RECREATION BENEFITS
ARISING FROM
LAKE RECLAMATION IN ONTARIO

Prepared for:

Ontario Ministry of
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ABSTRACT

The Ontario Ministry of Environment has set up the Inland Lakes Program to oversee the management of the quality of the aquatic resources of Ontario. The Inland Lakes Program identifies water quality problems and priorizes management and reclamation initiatives based on a variety of criteria. One criterion is the impairment of recreation value.

The overall purpose of this study is to provide an analytical framework to assess the economic implications of specified lake reclamation projects.

To illustrate the analytical framework, it was applied to one possible lake reclamation activity -- a 25% reduction in phosphorus concentration for six lakes.

This reclamation activity would yield an additional 50,000 recreation days with an associated economic value of about $1.5 million. Increased local expenditures are estimated to be $1.5 million and generate about 40 person years of employment.

The study also points out the dearth of good recreation data for Ontario lakes.

RÉSUMÉ

Le ministère de l'Environnement de l'Ontario a mis sur pied le programme de protection des lacs intérieurs afin de superviser la gestion de la qualité des ressources en eau de l'Ontario. Dans le cadre de ce programme, une étude est effectuée afin de déterminer les problèmes de qualité de l'eau lacustre et, selon divers critères, d'établir l'ordre de priorité des mesures de gestion et d'assainissement On retrouve parmi ces critères la perte de la valeur récréative.

L'objet global de cette étude est d'établir un cadre de référence permettant d'évaluer les conséquences économiques de certains projets d'assainissement des lacs.

À titre d'exemple, on a utilisé ce cadre de référence pour un projet que l'on pourrait mettre en oeuvre afin de réduire de 25 pour 100 la concentration de phosphore dans six lacs.

Ce projet permettrait d'augmenter de 50 000 le nombre de jours d'utilisation des lacs à des fins récréatives, ce qui représente sur le plan économique une valeur de 1,5 million de dollars. On évalue l'augmentation des dépenses locales à 1,5 million de dollars. Le projet se traduirait par quelque 40 années-personnes d'emploi.

Cette étude révèle également le manque de données satisfaisantes sur les lacs de l'Ontario en matière de loisirs.

ABSTRACT

The recreation use of many Ontario lakes is impaired by water quality problems such as acidification, eutrophication, or contamination. These problems can lead to loss of economic value or enjoyment by recreationists, and to loss of economic activity or sales by the recreation service sector.

The Inland Lakes program of the Ontario Ministry of the Environment oversees the management of the quality of the aquatic resources of the Province. This study provides an analytic framework to assess the economic implications of lake reclamation projects. The framework is applied to one possible lake reclamation activity -- a 25% reduction in phosphorus concentration.

Six lakes were selected as case studies -- Three Mile, Vernon, Mary and Fairy Lakes in the Muskoka/Haliburton region and Rice and West Lakes in Southeastern Ontario. The study focusses on three aquatic-based recreation activities -- sport fishing, swimming, and boating.

The economic framework has two components, economic value and economic impacts. The economic value of aquatic-based recreation is the value of the recreation "experience" as measured by recreation days. Economic impacts refer to the incremental expenditures, income or value added, and employment associated with changes in recreation activity or days of recreation use.

Lake reclamation activities cause changes in economic value and economic impacts through improvements in recreation quality. Changes in recreation quality affect the number of recreation days, and consequently cash expenditures by recreationists, and the enjoyment or value of each recreation day. Important recreation quality factors are: catch rates of preferred species for fishing, water clarity for swimming, and lack of aquatic plant growth for boating.

A 25% reduction in phosphorus on Rice Lake results in a $1.1 million increase in economic value, and results in $0.9 million in value-added and 30 person-years of employment annually to the Province. Provincial economic impacts are greatest for Rice Lake of the six lakes considered since the lake supports a large level of recreation use, since a large share of that use is by out-of-province residents, and since fishing is the main recreation activity on the lake. Fishing activity is more responsive to changes in recreation quality than are swimming and boating activities.

The empirical work of the study was impeded by the imprecision of the linkages between lake biophysical properties and recreation quality factors, and by the lack of behavioural information on Ontario recreationists. These deficiencies should be addressed through future research by the Ministry.

EXECUTIVE SUMMARY

A number of environmental factors affect the recreation use of a lake by affecting quality attributes of the recreation experience. These quality features, in turn, affect the level of recreation use on the lake, the value or enjoyment of people using the lake for recreation, and the level of expenditures made by recreationists in the local area. Consequently, changes in lake environmental conditions have economic repercussions.

The recreation use of many Ontario lakes is impaired by problems such as acidification, eutrophication, contamination, or some combination thereof. Acidification may lead to the decrease or elimination of fish populations for anglers. Eutrophication may result in algae blooms and the excessive growth of aquatic weeds -- factors that inhibit the use and enjoyment of a lake for fishing, swimming and boating. Contamination by heavy metals or organic compounds may cause fish to be unsuitable for human consumption.

The Ontario Ministry of Environment has set up the Inland Lakes Program to oversee the management of the quality of the aquatic resources of Ontario. The Inland Lakes Program identifies water quality problems and priorizes management and reclamation initiatives based on a variety of criteria. One criterion is the impairment of recreation value.

The overall purpose of the this study is to provide an analytical framework to assess the economic implications of specified lake reclamation projects.

To illustrate the analytical framework, it was applied to one possible lake reclamation activity -- a 25% reduction in phosphorus concentration.

Six lakes were selected as case studies. The lakes encompass two major classes of eutrophication problems -- algae and weeds -- as well as a contamination problem. Lakes included in the study are:

Lake	Primary Problem
West	eutrophic (weeds)
Rice	eutrophic (weeds)
Three Mile	eutrophic (algae)
Vernon	contaminants (mercury)
Mary	contaminants (mercury)
Fairy	contaminants (mercury)

West Lake is in Prince Edward county, south of Belleville; Rice Lake lies just south of Peterborough; and Three Mile, Vernon, Mary and Fairy Lakes are in the Muskoka/Haliburton districts.

The study focusses on three aquatic-based recreation activities -- sport fishing, swimming, and boating (including sailing, canoeing, water skiing and wind surfing). The importance of each activity varies across the lakes. Fishing is the most important recreation activity on Rice Lake, while swimming or general relaxation is the predominant activity on the other five lakes.

Major information sources for the study were a survey of 40 resort owners, a survey of 20 local officials (governments and tourism industry), and secondary data, reports and publications.

1.0 Current Recreation Use

Present (1985) recreation use on the six lakes is estimated at more than 2.2 million recreation days. Rice Lake is the largest and most popular lake, accounting for over 1.2 million recreation days.

Table 1: Current Recreation Use (000s days)

Residence	Lake					
	West	Rice	Three Mile	Vernon	Mary	Fairy
Local	30.3	69.6	9.0	28.8	20.8	18.4
Other Ontario	313.4	757.6	152.8	184.5	182.7	15.7
Out-of-Province	43.3	394.2	1.2	16.2	16.9	4.0
Total	**387.0**	**1221.4**	**163.0**	**229.5**	**220.4**	**38.1**

Rice Lake has the largest share of out-of-province recreationists (32% of all days) of the six lakes, reflecting use by residents of Ohio, New York state, etc. Use by Ontario residents from outside the local region, however, accounts for most of the recreation days on every lake, except Fairy Lake. On Fairy Lake there are a large number of year-round residents, but few resorts.

According to resort owner and local official interviews visible water quality problems are much more severe on Rice, West and Three Mile -- the eutrophic lakes -- than on Vernon, Mary, and Fairy -- the mercury contaminated lakes. In fact, by and large, resort owners and their clientele on the latter three lakes do not appear to be aware of mercury contamination problems.

Fishing quality problems on Rice, West, and Three Mile are primarily related to low catch rates for walleye (pickerel) although problems with worms or sores in the fish were also noted.

Weed and algae growth also impair the use of the eutrophic lakes for swimming and, to a lesser degree, boating. On West Lake, the natural flushing of the lake has been severely inhibited by sand build-up at the narrow outlet to Lake Ontario.

2.0 Water Quality and Recreation Use

In order to analyse the economic implications of a lake reclamation project, the project's effect on water quality and, in turn, recreation quality must be identified. The linkages between recreation activity, main recreation quality feature, and lake biophysical parameters used in this study are:

Activity		Main Recreation Quality Factor		Biophysical Parameter
fishing	<-------	catch rates preferred species	<----	MEI/phosphorus concentration
swimming	<-------	water clarity (Secchi depth)	<----	chlorophyll a concentration
boating	<-------	lack of aquatic plant growth	<----	chlorophyll a concentration

The catch rate for preferred species by anglers is affected by both the morphoedapic index (MEI) and phosphorus concentrations. A decrease in the MEI (total dissolved solids divided by mean depth) of a lake will decrease the total biomass of fish in the lake. A decrease in phosphorus level of a lake will increase the proportion of fish biomass comprising large predators (piscivores) such as walleye, yellow perch, etc. -- the preferred species of Ontario anglers.

Decreases in chlorophyll a concentrations will increase water clarity (Secchi disc readings) and decrease aquatic plant growth -- quality features of swimming and boating respectively.

Empirical relationships between lake phosphorus levels, biophysical parameters and main recreation quality features were developed from available research and data. The relationships, however, are imprecise.

3.0 Economic Framework

The framework for analysing the economic implications of lake reclamation projects consists of two components -- economic value and economic impacts.

Changes in economic value measure the effect a lake reclamation project has on aggregate economic output or well-being of society. The economic value of aquatic-based recreation is the value of the recreation "experience" as measured by recreation days.

The individual recreationist acts as both consumer and producer (through the use of time, equipment, and other inputs) of the recreation experience. The economic value of recreation is the net value or surplus recreationists receive from this joint activity, i.e., the difference between what they are willing to pay and the cost they actually incur. This value is called consumer surplus. Because no competitive market exists for providing recreation services, imputed market methods are required to estimate appropriate monetary values.

Change in economic value is the difference in the economic value before and after the lake reclamation project. Specifically, value is measured as the average consumer surplus per recreation day times the number of recreation days. A lake reclamation project, through changes in the quality of recreation, will affect both average consumer surplus or enjoyment per day and the number of recreation days.

The magnitudes of these effects depends on the magnitude of change in recreation quality and recreationists' responsiveness to changes in recreation quality. The responsiveness, or "elasticities", of recreation use and value that are used in this study are drawn from results in jurisdictions outside Ontario. No Ontario-specific empirical work exists.

Economic impacts refer to the expenditure, income and employment impacts associated with changes in recreation activity. Impacts include direct (tourism industry), indirect (suppliers to the tourism industry), and induced (consumption spending of wage income) components.

Economic impacts arise from incremental expenditures -- expenditures which would not have occurred in the region without the lake reclamation project. Incremental expenditures are deemed to the be those associated with incremental recreation days by non-locals. It is probable that expenditures by local residents represent a reallocation of expenditures from other businesses in the region.

Incremental expenditures are measured as the change in recreation days due to the lake reclamation project times average expenditure per day. Income and employment multipliers are applied to incremental expenditures to estimate economic impacts.

For both types of economic analysis, two main interest groups exist -- the local region (i.e., the region in which the project is undertaken) and the Province of Ontario. Economic value and impacts accruing to local residents only are included in the local region analysis. Economic values and impacts accruing to all Ontario residents are included in the provincial analysis.

4.0 The Case of Phosphorus Control

The economic framework is illustrated in the context of a 25% reduction in phosphorus for each of the six lakes under study. The specific lake reclamation activity causing the phosphorus reduction is unspecified. It could include restrictions on agricultural runoff or sewage effluent.

It is assumed that phosphorus reduction occurs instantaneously. The resulting changes in economic value and

TABLE 2: SUMMARY OF ANNUAL CHANGES IN RECREATION DAYS, ECONOMIC VALUES AND OF ECONOMIC IMPACTS DUE TO A 25% REDUCTION IN PHOSPHORUS

	Lake						
	West	Rice	Three Mile	Vernon	Mary	Fairy	All
Incremental Recreation Days ('000)	7.8	34.1	3.2	2.5	2.2	0.4	50.2
Change in Recreation Values ($000)[a]							
to Local Residents	12	47	4	8	5	5	81
to Provincial Residents[c]	266	1073	133	108	100	14	1694
Economic Impacts							
Local Region Impacts							
Inc. Expenditures ($000)	212	1104	53	61	62	6	1498
Income Impacts ($000)[b]	138	773	32	37	37	4	1021
Employment Impacts (PY's)	6	31	1	1	1	-	40
Provincial Impacts							
Inc. Expenditures ($000)	40	600	1	8	8	2	659
Income Impacts ($000)[b]	49	750	1	11	10	3	824
Employment Impacts (PY's)	2	30	-	-	-	-	32

[a] economic (satisfaction) values
[b] value added
[c] includes local residents

economic impacts represent annual changes or impacts in perpetuity (Table 2).

The decrease in phosphorus results in an additionsl 50,200 recreation days over all six lakes, ranging from a high of 34,100 additional days for Rice Lake to a 400 day increase for Fairy Lake. In relative terms, recreation days increase from 1-3% for each lake (see Table 1).

Lakes with higher proportions of fishing activity, as opposed to boating and swimming activities, experience the largest relative gains. This reflects the higher responsiveness of fishing activity to quality improvements, and the greater increase in fishing quality, as compared to boating and swimming activities, under phosphorus control.

The 25% decrease in phosphorus results in an increase in fishing, boating, and swimming quality; and, consequently, an increase in the satisfaction, enjoyment or value people receive from engaging in these activities.

Increases in economic (satisfaction) value are modest for the local regions under study, ranging from $4,000 for Three Mile Lake to $47,000 for Rice Lake. This mainly reflects the fact that very little of the current recreation use of the lakes is by local residents. The majority is by other Ontario or out-of-province residents.

Changes in value at the provincial level represent changes in value by local residents plus changes in value by other Ontario residents. Ontario residents recreating at Rice Lake receive benefits in excess of $1 million due to phosphorus control. Provincial residents recreating at Fairy Lake receive a benefit of $14,000.

Changes in recreation quality result in income and employment impacts through the increase in recreation activity and, consequently, cash expenditures by recreationists.

Incremental local expenditures by recreationists from a 25% reduction in phosphorus are $1.5 million in total for the local regions surrounding the six lakes (Table 2). The bulk of this total occurs in the Rice Lake local area. Incremental expenditures due to phosphorus control at Fairy Lake are minimal for the local area ($6,000).

This $1.5 million in incremental local expenditures result in $1.0 million in income (wages and salaries plus gross capital return) and 40 person-years of employment to the six local regions. Over 70% of these economic impacts occur in the Rice Lake local area.

At the provincial level, economic impacts are only significant for Rice Lake ($750,000 income and 30 person-years employment). Impacts from phosphorus control at Rice Lake represents over 90% of total impacts across the six lakes. This occurs because Rice Lake has substantial visitation by out-of-province recreationists. The other five lakes have very little out-of-province visitation. At the provincial level, economic impacts only occur from incremental expenditures by out-of-province recreationists.

The results indicate that changes in economic value and economic impacts arising from a 25% reduction in phosphorus are modest for Vernon, Mary and Fairy lakes. These modest impacts occur for two reasons.

First, the three lakes are smaller and support a lower level of recreation use than do West and Rice lakes. Secondly, eutrophication is not a major problem on these three lakes. Hence, phosphorus control would not be expected to generate substantial economic benefits or impacts. The case of phosphorus control was chosen to illustrate the analytical framework for measuring the economic repurcussions of lake reclamation activities.

5.0 Future Research

Data and information to support the empirical work in this study were drawn mainly from secondary sources -- information which largely related to fishing activity and which largely related to jurisdictions outside Ontario.

The use of secondary data and empirical results from outside the province was necessary because of the dearth of recreation information for Ontario lakes.

Two classes of information deficiencies represent major impediments to further work:

- the relationships for linkages between lake biophysical properties (e.g., phosphorus levels) and recreation quality factors (e.g., catch rates of preferred species) are imprecise, and
- no information exists as to the behaviour, motivations, expenditures, and substitute recreation activities of aquatic-based recreationists in Ontario (especially for swimmers and boaters).

These deficiencies should be addressed by the Ministry.

The first area could be addressed by sponsoring research to investigate the linkages between lake biophysical properties and recreation quality.

The second area could be addressed by sponsoring an on-site survey of aquatic-based recreationists for one or more lakes in the province.

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1.0 INTRODUCTION

A number of environmental factors affect the use of a lake for fishing, swimming, and boating by affecting quality attributes of the recreation experience. These quality features, in turn, affect the level of recreation use on a lake, the value or enjoyment of people using the lake for recreation, and the level of expenditures made by recreationists in the local area. Consequently, changes in lake environmental conditions have economic repercussions.

The recreation use of many Ontario lakes is impaired by problems such as acidification, eutrophication, contamination, or some combination thereof. Acidification may lead to the decrease or elimination of fish populations for anglers. Eutrophication may result in algae blooms and the excessive growth of aquatic weeds -- factors that inhibit the use and enjoyment of a lake for swimming and boating. Contamination by heavy metals or organic compounds may cause fish to be unsuitable for human consumption.

Reclamation activities in such impaired lakes can mitigate or eliminate the above environmental problems. The Ministry of Environment has set up an Inland Lakes Program to oversee the management of the quality of the aquatic resources (as represented by the more than 200,000 inland lakes in the province). The ultimate aims of the program are to develop comprehensive water management plans for specific inland lakes and to implement these plans through a combination of source control and system rehabilitation strategies.

The Inland Lakes Program identifies water quality problems and prioritizes management and reclamation initiatives (in consultation with other resource-related ministries) based on:

- the nature of the problem
- the severity of the problem

. adverse impacts on sport fisheries
. special ecological concerns.

Another criterion is the impairment of recreational value. To judge the desireability of a particular reclamation activity, therefore, the level of recreation benefits attributable to the activity must be evaluated.

The overall purpose of this study is to provide an analytic framework to assess the recreation benefits and impacts of specified reclamation projects. That is, linkages between lake environmental factors (which define recreation quality) and economic value/impact need to be specified. No such framework presently exists for use by the Ontario Ministry of Environment.

The specific objectives of this study are:

- to develop an analytic framework to estimate the change in aquatic based recreation demand (i.e., for sport fishing, swimming, boating), value and economic activity resulting from the reclamation of environmentally impaired lakes;

- to document the current status of recreation use, economic value, and economic activity for a group of selected lakes in Ontario; and

- to apply the analytical framework to the group of lakes under selected reclamation scenarios.

In short, the study will develop an economic framework and illustrate its utility through application to specific lakes and reclamation initiatives.

The remainder of this report is structured as follows:

- Section 2.0 presents an overview of the study's approach, including information sources, data collection activities, and lake selection.

- The study areas are discussed in Section 3.0 in terms of the specific lakes under scrutiny and the subprovincial regions corresponding to "local" areas. Section 3.0 also presents baseline data on recreation use and perceptions of water quality issues in the study areas.

- Section 4.0 explores the role of water quality in recreation activity in Ontario and the linkages between lake biophysical properties and recreation quality.

- A framework for economic value analysis (based on a recreation demand curve) and for economic impact analyses (based on economic multiplier analysis) is developed in Section 5.0.

- The data needed to operationalize the economic framework of Section 5.0 are presented in Section 6.0.

- In Section 7.0 the economic value and impacts of lake reclamation scenarios are estimated for selected lakes.

- Finally, in the concluding section future avenues of research are identified.

2.0 STUDY APPROACH

People participate in a particular recreation activity based on the quality attributes of the activity. For example, quality attributes of the recreational fishing experience include the weather, the scenery, congestion on the lakes, as well as the catch rate. Water quality is an important attribute of the sport fishing experience through its impact on catch rates and aesthetic factors (such as water clarity). Similarly, weed growth, algae levels and other factors represent quality variables for swimming and boating recreation activities.

The current water quality on a lake affects the current levels of recreation activity on the lake. Changes in water quality, in turn, cause changes in levels of recreation use, value and activity.

2.1 Approach for Economic Assessment of Lake Reclamation Projects

The approach or framework proposed for assessing aquatic-based recreational benefits and impacts from the reclamation of environmentally impaired lakes involves 8 steps:

1. Define the study area.
2. Determine the important "quality" attributes of aquatic-based recreation.
3. Determine lake biophysical-recreation quality linkages.
4. Estimate baseline recreation use, value, and expenditure data.
5. Develop recreation demand curve and economic impact framework.
6. Determine potential impact of a reclamation project on lake biophysical properties.
7. Determine potential impact of change in lake biophysical properties on recreation quality
8. Determine potential economic implications of change in recreation quality (i.e., on recreation use, economic

value and economic impacts).

Water-based recreation activities considered in this study are: fishing, boating (including sailing, canoeing, waterskiing and windsurfing), and swimming.[1]

The measure for recreation activity typically is taken to be a recreation (person) day -- a day, all or part of which is used in recreation activity by an individual. Thus, recreation days is the measure of "output" for recreation activity.

Many recreationists undertake more than one recreation activity in a given day. For this study, recreation days are classified according to the priority ranking -- fishing, boating, swimming. A fishing day is a recreation day in which an individual fishes. A boating day is a recreation day in which one boats. but does not fish. A swimming day is a recreation day in which one swims, but does not fish or boat.

Two broad classes of measures are used in the economic assessment of lake reclamation projects.[2] The first is a monetary measure of changes in economic value. The second class of measures covers economic impacts of recreation which refer to expenditure, income, and employment associated with recreation activities.

A more detailed explanation of the two classes of economic measures and their derivation is given in Section 5. From these two categories of measures, specific indicators used to assess lake reclamation projects are:

- economic value benefits
- expenditure impacts
- employment impacts
- income impacts.

Economic value benefits and impacts are estimated for both the local region around the lake and the province of Ontario.

2.2 Lake Selection

The framework for assessing economic benefits and impacts of lake reclamation projects was applied to six selected lakes. The Ministry of the Environment, in discussion with the consultants, chose the lakes for study. Initially, it was intended to choose at least one lake from each of the three main environmental problem classes -- acidification, eutrophication, and contamination.

The Ministry decided to eliminate the three acidified lakes within the city boundaries of Sudbury intially chosen since there were no resorts on these lakes -- i.e., the vast majority of users were permanent residents of Sudbury.

The lakes chosen encompass the two major classes of eutrophication problems -- algae and weeds -- as well as a contamination problem.

The lakes included in the study are:

Lake	Primary Problem
West	eutrophic (weeds)
Rice	eutrophic (weeds)
Three Mile	eutrophic (algae)
Vernon	contaminants (mercury)
Mary	contaminants (mercury)
Fairy	contaminants (mercury)

The location of the lakes is displayed in Exhibit 2.1.

The Rice Lake local area is defined to be the area within 25 miles of the lake. Communities on the border of Rice Lake include Bailieboro, Bewdley, Gores Landing, Harwood, Keene, and Roseneath. Peterborough and Cobourg are the major trade centres within the local area.

The West Lake local area is defined to be Prince Edward

EXHIBIT 2.1: THE STUDY LAKES

County and the area south of Highway 401 from Trenton to Belleville. The major trading centers are Belleville, Trenton, and Picton.

The local area for the other four lakes -- Three Mile, Vernon, Mary, and Fairy -- is taken to be roughly the area encompassed by the lakes and the major trading centres of Gravenhurst, Bracebridge, and Huntsville. The local area excludes Barrie and Owen Sound.

2.3 Information Sources

The major information sources for the study were:

- a survey of 40 resort operators;
- a survey of 20 local officials (governments and tourism industry);
- interviews and discussions with other individuals (e.g., government scientists and real estate people);
- secondary data, reports and publications.

Initially, it was intended to conduct only exploratory visits to the lake regions under study. These visits represented a means to gain insights into present recreation use patterns and into water quality problems. Secondary sources were intended to form the empirical data base for the study -- no primary data collection activities were to be undertaken.

Early in the study, however, it became apparent that little information was available on the level of activity or expenditures of individual recreationists on the lakes under study. Knowledge of the present level of recreation use is crucial to the assessment of recreation benefits of a reclamation activity on that lake.

In response, the consultants expanded the resort interview component into a major field survey of resort owners involving a detailed questionnaire. As well, the discussions with local officials were expanded into a formal survey.

The number of resort owners[3] interviewed in relation to the number of resort properties around each lake is given below:

Lake	Commercial Establishments* Total	No. Interviewed
West	25	8
Rice	67	16
Three Mile	6	4
Vernon	8	5
Mary	10	5
Fairy	3	2
Total	119	40

* Includes children's camps and marinas.

On West and Rice Lakes, where there are many resorts, we attempted to interview a "representative" cross-section of resort properties. On the lakes with few resort properties, resorts were chosen for interviewing primarily on the basis of availability of the operator.

The resort owner questionnaire has the following major sections:

- description of faciltiies/services provided
- recreation activity related to overnight accommodation (capacity, occupancy, day users, etc.)
- recreation activity at the marina facility (if applicable)
- recreation activity on the whole lake
- substitute lakes
- water quality issues
- resort revenues and employment.

A total of 20 individuals were interviewed using the local official questionnaire, as follows:

Completed Local Official Questionnaires

West Lake	5
Rice Lake	8
Muskoka/Haliburton Region	7
Total	20

The local official questionnaire has the following sections:

- lake facilities and recreation use
- local expenditure patterns
- water quality and recreation use.

Less structured interviews/conversations were also held with 15-20 officials. One real estate agent in the Muskoka/Haliburton area was interviewed.

Draft questionnaires were reviewed by Ministry personnel. As well, a formal pretest of 5 Rice Lake resort operators occurred during the last week of May, 1986.

The two surveys were conducted in June, 1986, using a personal interview format. The month of June corresponds to the time when operators are getting ready for the main tourist season of July/August. For each of the three major regions -- West Lake, Rice Lake, and Muskoka/Haliburton -- a team of two people conducted the personal interviews over 3-4 days.

The resort owner and local official questionnaires are given in Appendix H.

These survey activities represented a major addition to the work program for the study and the primary data collected form the basis for the recreation profiles on the six lakes which are presented in Section 3. Secondary information collected formed the basis for the estimates of economic value per recreation day and recreation expenditures, as well as the impacts of changing water quality on these economic parameters.

FOOTNOTES

1. Changes in water quality can affect other recreation activities, such as picnicking, walking, camping, etc. which are enhanced by proximity to water (Urban Systems Research and Engineering Inc., The Recreation Benefits of Water Quality Improvements: Analysis of Day Trips in an Urban Setting, Report Prepared for U.S. Environmental Protection Agency under contract EPA 68-01-2282, Washington, D.C., June 1976, p.7). These, however, are not the main focus of this study.

2. Ontario Ministry of the Environment, The Economics of Acid Precipitation: A Review of Socio-Economic Methods to Assess Acid Deposition Effects, Corporate Policy and Planning Branch, Toronto, January 1986.

3. Properties include only those with direct water access to the lake.

3.0 PROFILE OF RECREATION USE IN THE STUDY REGIONS

An understanding or profile of recreation use on each of the six lakes is required to estimate the likely impacts of water quality improvement. A key information requirement is the present level of recreation use, or recreation days, by region of residence. It is from this baseline information that changes in recreation activity due to changes in water quality are estimated.

In this section, profiles for the six selected lakes are developed under the broad headings: facility inventory, current recreation use, and water quality issues.

In support of the summary discussion in this section, Appendices B through G provide detailed "snapshots" of recreation use for each lake. Each appendix covers the following:

- a biophysical inventory (lake area, pH, secchi depth, etc.),
- a 1986 inventory of facilities (resorts by type, cottages, public facilities),
- estimates of recreation days of use (by facility type and residence of individual), and
- a listing of water and recreation quality concerns of resort owners.

The starting point for the recreation profile is the inventory of facilities.

3.1 The Recreation Service Sector

An inventory of recreation facilities on each of the six lakes is given in Exhibit 3.1. Since comprehensive information does not exist, these inventories represent estimates derived from the resort owner and local official

EXHIBIT 3.1: 1986 INVENTORY OF FACILITIES

	Lake					
	West	Rice	Three Mile	Vernon	Mary	Fairy
Number of Facilities[a]						
Resorts	24	62	6	7	9	2
Fixed Roof	12	38	4	3	5	1
Trailer/Campsites	12	24	2	2	1	-
Children's Camps	--	--	-	2	3	1
Marinas[b]	1	5	457	1	1	1
Seasonal/Permanent Residences	200	1382	457	272	200	107
Public Facilities						
Launching Ramps	2	7	1	2	2	1
Beaches	1	4	-	1	3	1
Resort Capacity						
Fixed Roof (units)	190	643	59	23	197	13
Trailer/Campsites (sites)	1384	1710	97	173	280	--
Camp Beds (beds)	--	--	--	541	486	120

[a] Commercial establishments are classified according to their major activity.

[b] Marinas with accommodation facilities are included under resorts.

surveys, accommodation guides, and secondary data provided by local officials.

Facilities can be categorized by:

- commercial establishments (resorts and marinas);
- seasonal (cottages) and permanent or year-round residences;and
- public facilities (launch ramps and beaches).[1]

Resorts providing accommodation can be further broken down into fixed roof (motels/hotels, cottages), trailer/campsite (seasonal and transient), and children's camps.

The pretest of the resort questionnaire indicated that the tourist industry classifies trailer sites as seasonal (which provide water and electricity hookups and can be rented by the season) and transient (which are rented by the day or weekend). This differentiation is maintained in the detailed facility inventories of Appendices B through G.

There are wide differences in the level of facilities as well as in the mix of facilities among lakes. For example, children's camps represent an important component of total resort capacity on Vernon, Mary, and Fairy Lakes. There are no children's camps on the other three lakes. Resort capacity on West Lake is dominated by trailer sites as opposed to fixed roof accommodation, in contrast to Rice Lake and Mary Lake. Rice Lake not only has many more resort facilities than the other lakes, it also has more than six times as many residences along its shores.

Some of these differences in facilities can be ascribed to the sizes of the lakes as measured by surface area:

Lake	Surface Area (hectares)
West	2036
Rice	10018
Three Mile	929
Vernon	1443
Mary	1061
Fairy	732

Differences in infrastructure are partly due to differences in recreation activity patterns (e.g., fishing parties prefer cottages as opposed to trailer sites) and to the nature of agricultural and commercial development surrounding the area.

3.2 Existing Recreation Use

Current recreation use in terms of recreation days of each of the three main classes of facilities over the May through October period was estimated as follows:

- commercial accommodation -- use of resorts in the sample was based on reported occupancy rates and average number of people per unit; sample resort use was extrapolated to all resorts based on ratios of resort units in the sample to that in the population of all resorts.

- seasonal/permanent residences -- based on estimated household size and number of days used for recreation during the summer.

- public facilities -- based on local official or resort operators' observations and on size and type of facilities (e.g., parking lot capacity).

Details on the exact methodology used to determine existing recreation use are given in Appendix A.

A summary of recreation use estimates by lake and facility type is given in Exhibit 3.2. The estimates include both visitor and local resident use.

Rice Lake has the most recreation use (over 1.2 million recreation days) and Fairy Lake has the least (38,100 recreation days). On Three Mile Lake and Fairy Lake, the majority of use is derived from cottages/year-round residents. On the other lakes, the majority of use is

EXHIBIT 3.2: ESTIMATES OF RECREATION DAYS BY FACILITY TYPE AND RESIDENCE CLASS (MAY-OCT.)

	Lake					
	West	Rice	Three Mile	Vernon	Mary	Fairy
Use by Facility Type	. . . '000 recreation days . . .					
Fixed Roof	49.5	332.1	16.8	12.9	66.1	3.2
Trailer/Campsites	192.1	411.5	20.1	47.5	35.5	---
Children's Camps	---	---	---	68.7	50.2	6.3
Marinas[a]	90.9	70.6	0.2	6.6	1.6	4.7
Commercial Facilities (Subtotal)	332.5	814.2	39.1	135.7	153.4	14.2
Seasonal/Permanent Residences	52.0	373.2	123.4	72.8	52.0	21.4
Public Facilities	2.5	34.0	0.5	21.0	15.0	2.5
Total	387.0	1221.4	163.0	229.5	220.4	38.1
Use by Residence Class						
Locals	30.3	69.6	9.0	28.8	20.8	18.4
Rest of Ontario	313.4	757.6	152.8	184.5	182.7	15.7
Rest of Canada	23.3	---	0.4	8.1	7.7	0.9
Outside Canada	20.0	394.2	0.8	8.1	9.2	3.1
Total	387.0	1221.4	163.0	229.5	220.4	38.1

Source: Derived from resort owner survey and information from accommodation guides and local officials using the methodology outlined in Appendix A.

[a] Includes day users at marinas associated with establishments providing accommodation.

derived from commercial establishments. Recreation days emanating from children's camps exceed 50,000 recreation days for each of Lake Vernon and Mary Lake. Use of public facilities on the six lakes represents a small proportion of total recreation use.

The proportion of recreation days by residence of the recreationist and type of facility is applied to recreation day estimates in Exhibit 3.2 to generate estimates of recreation use by local residence, other Ontario residence, and out-of-province users. These are needed to calculate different economic values and impacts for the local region and the province.

	Use by Residence (% of total recreation days)					
	West	Rice	Three Mile	Vernon	Mary	Fairy
Local	8	6	5	13	9	48
Rest of Ontario	81	62	94	80	83	41
Out of Province	11	32	1	7	8	11
Total	100	100	100	100	100	100

Rice Lake has the largest share of out-of-province recreation use (32% of all recreation days), reflecting use by residents of Ohio[2], New York State, etc. The relatively large local use of Fairy Lake (48%) reflects the lack of resorts on the lake and the large number of year-round homes/cottages.

Data are not available to precisely estimate the number of recreation days by activity -- fishing, swimming, boating, or other (general relaxation). However, rankings of use by activity type can be made on the basis of the resort owner and local official interviews at each lake:

Priority of Use	West	Rice	Three Mile	Vernon	Mary	Fairy
1 (highest)	swim	fish	relax	swim	swim	swim
2	relax	swim	swim	boat	boat	relax
3	fish	boat	boat	relax	relax	boat

3.3 Water Quality Issues

According to resort owner and local official interviews, visible water quality problems are much more severe on Rice, West, and Three Mile Lakes -- the eutrophic lakes -- than on Vernon, Mary, and Fairy -- the mercury contaminated lakes.[3] In fact, by and large, resort operators and their clientele on the latter three lakes do not appear to be aware of mercury contamination problems.

Fishing quality problems on Rice, West, and Three Mile are primarily related to low catch rates for walleye (pickerel) although problems with worms or sores in the fish were also noted.

Walleye (the preferred species of Ontario anglers) and pike populations have dropped dramatically in West Lake. Many former West Lake anglers now fish the high quality walleye fishery in the Bay of Quinte.[4]

The appeal of these lakes has declined in some fishermen's views because of difficulty of manoeuvering boats and accessing fish due to weed and algae growth.

Weed and algae growth also impair the use of the lakes for swimming and, to a lesser degree, boating. On West Lake, the natural flushing of the lake has been severely inhibited by sand build up at the narrow outlet to Lake Ontario.

Additional detail on water quality issues in the six lakes is given in the supporting appendices (i.e., Appendices B through G). The role of water quality in recreation use is investigated further in the next section.

FOOTNOTES

1. Public facilities represent public infrastructure for which entrance and/or user fees are not levied.

2. C.A. Lewis, 1979 Creel Census: Rice Lake and Otanabee River. Kawartha Lakes Fisheries Unit (Manuscript report).

3. Some older lake trout in Lakes Mary, Fairy, and Vernon have been found with mercury levels up to 20 times higher than the guideline for unrestricted consumption. Outside of the English-Wabigoon system, these fish are the most mercury-contaminated in Ontario.

4. Interviews with resort operators and local officials at West Lake.

4.0 WATER QUALITY AND RECREATION USE

The linkages or relationships between lake water quality and recreation quality are identified in this section. First, however, the determinants, quality features, and dynamics of recreation activity are discussed.

4.1 Determinants of Recreation Use

The amount of recreation use on a lake is determined by a number of factors. These factors relate to the economic costs of participation, socio-economic characteristics of potential recreationists, on-shore site characteristics and facilities, aquatic-based recreation quality characteristics, and the availability and cost of recreation substitutes.[1]

Economic costs include travel cost, the imputed value of travel time, direct entrance/parking fees, and the costs of associated goods and services such as accommodation, meals, recreation equipment etc.

Socio-economic characteristics include income, education, age etc.

On-shore site characteristics include the setting (agricultural, residential, etc), the availability of facilities (such as accommodation, restaurants, marinas, and bait and tackle shops), and beach quality (amount and quality of sand, litter, etc).

Recreation substitutes include other lakes in the area or province, non aquatic-based outdoor recreation opportunities such as camping, and leisure activities in the region of residence.

Aquatic-based recreation quality attributes include catch rates of preferred species (for fishing), water clarity (for

swimming), and weed density (for boating).

Site characteristics -- both onshore and water quality -- affect the level of use of a lake for recreation, as well as the "value" or satisfaction of recreation users of the lake. The level of use, in turn, affects recreation expenditures and, hence, economic activity (employment and income) associated with recreation.

Changes in site characteristics cause changes in recreation use, value and economic activity. Below important water quality attributes affecting aquatic-based recreation are discussed in detail.

4.2 Recreation Quality Factors Related to the Lake Environment

Recreation quality factors related to the lake environment for fishing, swimming, and boating are itemized below.

Fishing	Swimming	Boating
. species present	. turbidity	. weeds
. abundance	. weeds	. crowding
. size of fish	. algal blooms	. turbidity
. fitness of fish for eating	. crowding	. algal blooms
. crowding	. bacterial counts	
. turbidity	. water temperature	

A key component of the enjoyment of recreational fishing is the amount of fish of preferred species caught during the angling trip (i.e., angling success). Anglers target on large fish, on species providing a "good fight", and on species preferred for eating. Walleye is the preferred species of anglers fishing Ontario water[2], followed by trout and bass.

The abundance of fish in a lake determines to a large extent the catch rate. The abundance of fish in a lake is related to biophysical characteristics of the water body such as pH.

The Ontario Ministry of Environment publishes an annual guide of recommendations for the safe consumption of fish harvested from specific water bodies in Ontario.[3] It is advised that fish caught from some lakes not be consumed by humans.

Quality factors such as scenic beauty, weather, solitude (or its opposite, crowding) and water quality attributes not related to catch rates such as water clarity, also affect the quality of the fishing experience.[4]

Generally, quality factors for swimming can be categorized as health-related and as enjoyment-related. As a rule, water bodies with low turbidity (high water clarity) and few weeds or algae are the most pleasant for swimming. High bacterial or coliform counts may make water unsafe for swimming and can cause eye and ear irritations, stomach problems if ingested, and so on. Water temperature affects both the enjoyment and the health aspects of swimming. Crowding of beaches can inhibit the enjoyment of swimming.

Boating activities are affected by the presence of weeds which get entangled in propellers. Water turbidity and algal blooms inhibit the aesthetic enjoyment of power boating, sailing, canoeing, etc. Crowding of waters can impede or slow navigation.

4.3 Dynamics of Recreation Use

An understanding of the dynamics of recreation use aids in determining the impacts of changing recreation quality on the recreation decisions of where to go, how long to stay and so on.

The level of recreation use depends not only on the demand for recreation but also on the "supply" of recreation services. The availability of facilities is important to recreation choice.[5] In the West Lake area, for example, resorts are fully booked in July and August. During this

period, improving water quality will not translate into increased use of resorts unless new facilities are opened.

Custom, habit, and seasonal factors affect the level and pattern of recreation use of a lake to a large degree. Many families take their holidays in July and August when children are not in school, and when air and lake water temperatures are high.

Beneficial changes in water quality as reflected through angler catch rates have a greater potential to increase fishing use in the spring and fall shoulder periods (i.e., May/June and September/October, respectively) than do beneficial changes in boating or swimming quality attributes.

Many recreation parties seek a "composite experience" at a lake or destination where individual group members can fish, swim, boat or just generally relax (e.g., father relaxes on the beach; children swim; mother goes fishing). All party members may not have the same aquatic interests. Groups of "hard core" fishermen represent an exception in that the primary/only reason for visiting a lake may be the fishing opportunities present for the individuals.

Changing water quality may enhance one type of recreation activity at the expense of another. For example, increasing the pH of a lake through liming can increase fish populations -- a benefit to fishing activity -- but decrease water clarity -- a disbenefit to swimming and boating. As well, turbid, weed-infested water environments enhance populations of certain species of fish, but reduce the lake's appeal to swimmers.

Particular lake environments largely reflect natural geophysical parameters such as depth, surface area, and bottom type or substrate. For example, the generally poor water clarity of Three Mile Lake largely reflects the fact that the lake is shallow. It is unreasonable to expect the

water clarity on Three Mile to be similar to that on Lake Rosseau -- a clear deep lake. In fact, the reason Three Mile has supported walleye populations to a greater degree than other lakes in the area is due in large measure to its shallowness. Recreationists accept the fact that different lakes have different water quality in terms of colour, clarity, etc. and do not necessarily see such differences as "problems".

It is not uncommon for differences to exist between perceived water quality and actual water quality.[6,7] Individuals make decisions based on perceived water quality. Sometimes, publicity concerning acid rain, coliform counts, mercury contamination, etc. can have a more pronounced impact on recreation use than the actual level of water quality.

For some activities, such as swimming, the number of recreation days may be relatively invariant over a wide range of water quality if the change cannot be easily detected through the senses of sight, taste and touch. For example, high coliform counts in a lake may not inhibit swimming activity unless the beach is formally closed.

The perceptions of changes in recreation quality differ among fishing, swimming and boating activities. Fish abundance and hence catch rates can be highly variable in a stable lake environment from year to year due to vagaries in recruitment, natural mortality, and angling pressure. Anglers do not necessarily attribute a drastic change in fishing success from one year to another to changes in water quality. There is significant natural variability around annual catch per unit effort on a given water body.

In contrast, annual changes in swimming and boating quality related to the aquatic environment are more likely to reflect real changes in the biophysical lake environment, but such changes occur gradually over time.

The profiles of recreation use in the study areas given in Section 3.0 indicate the following cross classification system of recreation use:

Activity	Venue	Residence
fishing	resort	local
swimming	cottage/residence	rest of Ontario
boating	public facility	rest of Canada
other		outside Canada

Each of the 48 (4x3x4) categories represent a distinct segment of recreation use. Each segment may have different levels of satisfaction/value with the recreation experience, and may have different levels of daily expenditures. These differences give rise to different economic values and economic impacts.

Each segment also may have a different degree of response to changing water quality. For example, cottage use represents a more "captive" recreation demand with respect to changing water quality than does resort or day use: cottagers on a particular lake have a fixed investment and are more likely to use that investment for recreation regardless of changes in water quality after purchasing the property. A survey of amenity values in Ontario found that a much larger share of local residents or cottage owners in the area would continue to visit the Muskoka/Haliburton or Kawarthas vacation areas if fishing opportunities were not available, compared to urban Ontario residents and US residents.[8]

The responsiveness of recreation activity to changing recreation quality depends critically on the availability of substitute activities. There has been a large decline in angling activity on West Lake in response to declining walleye populations there, and the relative proximity of the recently emerging high quality walleye fishery on the Bay of Quinte.

As a rule, there are many lakes available for recreation use in Ontario; nor does there appear to be a large unfulfilled demand for aquatic-based recreation.[9] In most instances, recreation opportunities on a particular lake are not unique. As a result, changing aquatic-based recreation quality on a lake will have a much greater impact on recreation use on that lake than on recreation use in the province as a whole.

In summary, the responsiveness of recreation use to changing recreation quality is not uniform across all activity, venue, and residence combinations.

4.4 Biophysical Water Quality - Recreation Quality Linkages

Several biophysical factors or parameters affect the suitability of a lake for recreation use. These factors need to be translated into recreation quality variables or quality attributes that the individual recreationist acknowledges. First, the influence of biophysical parameters is discussed.

4.4.1 Biophysical Parameters

Important biophysical parameters that affect recreation use include:

- lake area
- mean depth
- total dissolved solids
- pH
- phosphorus concentrations
- chlorophyll *a* concentrations
- turbidity (Secchi disc readings)
- pathogenic bacteria and fecal coliform counts, and
- water temperature.

Lake area and mean depth determine the physical volume of water present that can support aquatic-based recreation activity. Mean depth also influences the type of fishing, boating and swimming activities possible. For example,

walleye prefer shallow turbid lake environments whereas lake trout prefer cold, clear, deep water lake environments.

The morphoedaphic index -- total dissolved solids divided by mean depth -- is a measure of the capability of a lake environment to support fish populations.[10] A lake with a higher morphoedaphic index is expected to have a higher population of fish, all other things equal.

Lakes with high concentrations of phosphorus are expected to have a low share of piscivores (walleye, pike, etc.) -- the preferred species of anglers -- in the total fish biomass.

The acidity of water, pH, is related to recreation in that pH values less than neutral (i.e., 7) give situations adverse to aquatic life (see Exhibit 4.1).

Acidic waters of say pH less than 5 usually do not support fish populations.[11] Acidic waters also are generally clearer than non-acidic waters so that slightly acidic lakes may be preferred for swimming or boating over non-acidic lakes.

Phosphorus is the key ingredient in stimulating algae and plant growth (i.e., eutrophication) in Ontario lakes.[12] It is the nutrient most frequently in limited supply to algae and vascular plant growth.[13] Sources of phosphorus can be agricultural fertilizer runoff, domestic sewage, domestic detergents or soaps, or other wastewaters.

The presence of algae has a more significant negative impact on the enjoyment of swimming than on the enjoyment of fishing or boating.[14]

Cholorophyll a concentrations -- the green photosynthetic pigment in algae -- are a measure of the amount of suspended algae in the water. They provide a rough indication of the degree of biological activity/biodegredation.

EXHIBIT 4.1: PRELIMINARY DAMAGE FUNCTIONS FOR SPORTS FISH IN EASTERN CANADA

Fish Species	pH for 100% Population Survival	pH for 50% Population Survival	pH for 0% Population Survival
Lake Trout (L) Arctic Char Rainbow Trout (R) Brown Trout GROUP 1	6.0	5.5	5.0
Atlantic Salmon (R) Large Mouth Bass (L) Walleye Brook Trout (R) GROUP 2	5.5	5.1	4.6
Pike Rock Bass Small Mouth Bass Perch GROUP 3	5.0	4.7	4.3

L - lake spawners
R - river spawners

Source: The DPA Group Inc., Assessing Future Economic Impacts of Acidic Depositions on the Sport Fishery of Eastern Canada, Report prepared for the Department of Fisheries and Oceans, Ottawa, 1986.

Water clarity as measured by Secchi disc readings is mainly influenced by cholorophyll a concentrations, although water colour and suspended particulate matter can also be influencing factors. The Secchi disc reading is the depth at which a small disc (20 cm in diameter) having alternate black and white quadrants disappears from view when lowered into a lake.[15]

Human health can be affected by pathogenic bacteria as indicated by the presence of fecal coliforms in lake water. Pathogens are generally introduced to the aquatic environment by raw or inadequately treated sewage. The presence of these bacteria does not change the perceived desireability of the lake unless legal limits are prescribed.[16] They can, however, pose an immediate health hazard if the water is used for swimming or drinking.[17]

Water temperature affects recreation use of a lake through the growth of algae and aquatic plants (macrophytes), specific fish populations (e.g., warm water species such as walleye versus cold water species such as lake trout), and through impacts on swimmers.

The biophysical inventories for the six lakes under study cover all the above biophysical parameters except bacterial counts and water temperature. (See Appendices B through G.)

4.4.2 Linkages

The above water quality parameters need to be linked to recreation quality attributes before the effects of lake reclamation initiatives on recreation use can be assessed.

The most important aquatic-based recreation quality features associated with the three main activities of fishing, swimming, and boating were identified based on a literature review and the interviews with resort operators and local officials. Parametric relationships between these recreation quality factors and one of the lake biophysical properties identified in Section 4.4.1 above were drawn from empirical work of other researchers.

The linkages between recreation activity, main recreation quality feature, and biophysical parameters to be used in this study are:

Activity		Main Recreation Quality Factor		Biophysical Parameter
fishing	<------	catch rates preferred species	<-----	MEI/phosphorus concentration
swimming	<------	water clarity (Secchi depth)	<-----	chlorophyll a concentration
boating	<------	lack of aquatic plant growth	<-----	chlorophyll a concentration

It is possible that a recreation quality feature may affect more than one activity. For example, one would expect recreational fishing use and value of a lake to be enhanced through higher catch rates, better water clarity and perhaps reduced plant growth.[18] However, for this study, changes in each aquatic activity value and use are effected only through changes in the main quality feature noted above.

For this study, phosphorus control is the reclamation activity chosen for empirical study (see Section 7.0). Accordingly, the linkages developed below have been tailored to this remedial activity. That is, empirical relationships are presented for translating changes in phosphorus levels to changes in MEI and chlorophyll a concentrations.

Alternately, if acidification or contamination control were to be investigated, then empirical linkages between lake pH or contaminant levels and MEI, phosphorus levels and chlorophyll a concentrations would need to be specified.

Fishing Quality

For this study, impacts of changing phosphorus levels on fish biomass of preferred species is modelled as a two stage process:

- impacts on total fish biomass (all species), and
- impacts on proportion preferred species in total biomass.

An increase in phophorus levels is associated with an increase in morphoedaphic index (MEI) which, in turn, is associated with an increase in total fish biomass in a lake. However, an increase in phosphorus is also associated with a decrease in the proportion of total biomass being large predators, such as walleye, pike and yellow perch--the species preferred by Ontario anglers. Little information is available as to the emphirical relationship between phosphorus, total fish biomass, and the share of the biomass composed of preferred species.

Biophysical data for Rice, Three Mile, Vernon, Many, and Fairy Lakes[19] were used to derive the following empirical relationship between MEI and phosphorus concentration, P (ug/l):

$$\ln MEI = -4.6 + 2.3 \ln P \qquad (1)$$

That is, a 1% change in P is associated with a 2.3% change in MEI.

It is recognized that the regression model is simplistic and is based on a small number of lakes. More work is required in quantifying the relationship between phorphorus levels and the MEI, or between phorphorus and total fish biomass. In the meantime, it was felt that the approach adopted was reasonable.

A parametric relationship between MEI and sustainable yield (all species) per square kilometer of surface water Y was developed by Ryder[20]:

$$Y = 137.8 \ (MEI)^{0.4454} \qquad (2)$$

This relationship is used to relate changes in MEI to changes in total fish biomass.

Eutrophication, or phosphorus loading, produces a stress in the fish community that inhibits the ability of large piscivores to compete successfully. As a consequence, smaller, short-lived species prosper in a phosphorus rich lake environment.[21] It is the large piscivores such as walleye that are the species preferred by anglers.

In the Bay of Quinte phosphorus control project, it was found that an approximate 25% decrease in phosphorus levels was associated with a substantial increase in the share of piscivore biomass to total biomass -- from roughly 20% piscivores before phosphorus control to more than 50% piscivores after phosphorus control.[22]

The Bay of Quinte (before phosphorus control) had higher phosphorus levels than any of the six lakes under study here. Nevertheless, the relative magnitude of the response to phosphorus reduction serves as a guide to the impact of phosphorus reduction on species mix for the lakes under study.

The share of piscivore biomass to total biomass has declined in West Lake in response to increased eutrophication.[23] Moreover, Rice Lake empties into the Bay of Quinte and is one of the major phosphorus sources to the Bay.

The species mix response rate observed for the Bay of Quinte has been dampened for this study. It is assumed that a 1% change in phosphorus (P) gives rise to a -4% change in proportion (p) of piscivore/preferred biomass, i.e., a species mix elasticity of -4.0:

$$\ln p = \text{constant} - 4.0 \ln P \qquad (3)$$

For example, if the share of preferred species (p) was .20 before a phosphorus reduction of 10%, then the new level of p would be .28.

The above relationship is approximate. The empirical relationship of fish species composition to changing phosphorus levels is an important area for future research.

Accordingly, the relationship between angler catch of preferred species per unit effort (CPUE) under different phosphorus levels on a given lake can be expressed as:

$$\frac{CPUE'}{CPUE^{o}} = \left[\frac{MEI'}{MEI^{o}}\right]^{0.4454} \times \left[\frac{p'}{p^{o}}\right] \qquad (4)$$

where

the superscript "o" indicates the old value
the superscript "'" indicates the new value (i.e., after the reclamation activity).

The ratio MEI'/MEI^{o} can be determined from equation (1). The ratio p'/p can be determined from equation (3).

Boating Quality

Chlorophyll *a* concentrations are a reasonable proxy for density of all aquatic plant growth.

Phosphorus is the main biophysical factor underlying aquatic plant and algae growth in Ontario Lakes. Changing phosphorus loadings also represent one possible method by which water quality can be managed. To our knowledge, no empirical relationship between phosphorus levels and total aquatic plant densities or concentrations has been developed. However, the following equation has been developed by Dillon and Rigler[24] relating phosphorus levels to chlorophyll *a* concentrations (which, as previously discussed, is a reasonable proxy for density of all plant growth):

$$\log_{10}[\text{chlor } a] = 1.45\,(\log_{10}[P]) - 1.14 \qquad (5)$$

where

P is phosphorus concentration in ug/l.

Decreased phosphorus levels will decrease macrophyte (aquatic plant) growth.

Swimming Quality

Secchi depth is a measure of water clarity. An empirical parabolic relationship between chlorphyll a concentrations and Secchi disc readings (water clarity) has been derived by Dillon and Rigler:[25]

$$SD = (0.1138 + 0.0386\ [\text{chlor } a])^{-1} \qquad (6)$$

where

SD is the Secchi disc reading in metres

chlor a is the chlorophyll a concentrations in ug/l.

The equation indicates that a decrease in chlorophyll a concentration arising from a specific lake reclamation activity can be translated into greater water clarity which, in turn, will encourage more swimming activity.

FOOTNOTES

1. The list of recreation quality factors is derived from the resort owner and local official surveys and from information in the study: Urban Systems Research and Engineering Inc., The Recreation Benefits of Water Quality Improvements: Analysis of Day Trips in an Urban Setting, Report Prepared for U.S. Environmental Protection Agency under Contract EPA 68-01-2282, Washington, D.C. June 1976. p. 49-65.

2. Ontario Ministry of Natural Resources, 1980 Surveys of Ontario's Resident and Non-Resident Sport Fishermen, Toronto p.71 and 147.

3. Ministry of the Environment, Guide to Eating Ontario Sport Fish 1986, Toronto.

4. Non catch-related attributes such as water quality, the scenery and the outdoor experience have been found to be important features of the recreational angling experience in Saskatchewan. The Saskatchewan fishery is similar to the Ontario sport fishery in terms of fishing modes utilized and in that walleye is the preferred species for anglers in both provinces.

A. Barber and D. Topolniski, "A Hedonic Travel Cost Survey of Saskatchewan's Sport Fishery: Progress Report", Regional Economic and Marketing Services, Department of Fisheries and Oceans, Winnipeg, May 1986.

5. Urban Systems Research and Engineering Inc. op.cit. p.xii.

6. Ibid p.x.

7. For example, most resort owners interviewed on Vernon, Fairy Lake, and Mary Lakes, as well as local officials, were not aware of the mercury contamination problem in these three lakes.

8. A.R.A. Consultants, Acid Precipitation Effects: Value Awareness and Attitudes in Ontario: The Activity Value Survey. Prepared for the Ontario Ministry of Environment, July 1981.

9. Ontario Ministry of the Environment, The Economics of Acid Precipitation: A Review of Socio-Economic Methods to Assess Acid Deposition Effects, Corporate Policy and Planning Branch, Toronto, January 1986, Chapter 4.

10. R.A. Ryder "A Method for Estimating the Potential Fish Production of North Temperate Lakes", Transactions of the American Fisheries Society, Vol 94: 214-218, 1965.

11. See Exhibit 4.1

12. Ontario Ministry of the Environment, Report on Water Quality in Three Mile Lake 1972, Toronto, p.A-11.

13. SPR Associates Inc. "Predicting the Presence of Filamentous and Odour Algae: A Pilot Survey of Cottages on Ten Ontario Recreational Lakes", Report Prepared for the Ontario Ministry of Environment, December 1985.

14. Hough Stansbury and Michalski Ltd., "Cottage Carrying Capacity for Forty-Four Lakes in the District Municipality of Muskoka: Volume I," March 1983 p.8.

15. Ibid. p.8.

16. Urban Systems Research and Engineering Inc. op.cit. p.60.

17. Hough, Stansbury, and Michalski Ltd, op.cit. p.A-1.

18. It is recognized that some plant growth is required to sustain fish populations and, in fact, certain fish populations thrive in dense weed infested lakes.

19. West Lake was excluded since the north and south basins of the lake have vastly different biophysical properties. The phosphorus MEI and data used to derive the relationship are given in Appendices C through G.

20. Ryder, op.cit.
Ryder's technique does have its limitations, but it remains a useful quantitative tool to fisheries managers.
Hough, Stansbury and Michalski Ltd., op.cit. p.51-52.

21. D.A. Hurley, "Fish Populations of the Bay of Quinte, Lake Ontario, Before and After Phosphorus Control", Canadian Special Publication of Fisheries and Aquatic Sciences 86, Ed. by C.K. Minns, D.A. Hurley and K.H Nichols, Ottawa, 1986, pp.201-214.

22. This represents a species mix elasticity in excess of -6 i.e. a 25% decrease in P gave rise to a greater than 150% increase in the share of piscivores in the total biomass.

Walleye populations increased dramatically after a large year-class occurred in 1978. This event occurred independent of phosphorus control. However, walleye does not form a major share of piscivore biomass in the Bay. Other species such as yellow perch do. Accordingly, the observed increase in piscivore biomass after phosphorus controls can not be attributed to the strong walleye year-class of 1979.

D.A. Hurley et al, "Trophic Structure and Interactions in the Bay of Quinte, Lake Ontario, Before and After Point-Source Phosphorus Control", Canadian Special Publication of Fisheries and Aquatic Sciences 1986, Ed. by C.K. Minns, D.A. Hurley and K.H. Nichols, 1986, pp. 259-270.

23. Ibid.

24. P.J. Dillon and F.H. Rigler, "The Phosphorus-Chlorophyll Relationship inLakes", Limnol. Oceanogr. 19:767-773, 1974.

25. P.J. Dillon and F.H. Rigler, " A Simple Method for Predicting the Capacity of a Lake for Development Based on Lake Trophic Status", Journal of the Fisheries Research Board of Canada, 32:1519-1531, 1975.

5.0 ECONOMIC FRAMEWORK

Lake reclamation projects change biophysical properties of a lake which, in turn, alter the quality of fishing, swimming, and boating on the lake (see Section 4.4). Changes in recreation quality cause changes in recreation use, value, and activity. In this section, an economic framework is presented for assessing these economic repercussions of changes in recreation quality of a lake.

The economic framework has two components -- an economic value (or welfare) component and an economic impact (or activity) component. Both economic value and economic impact measures are useful in analysing lake reclamation projects in Ontario. Economic values are important in assessing the effect of a lake reclamation project on aggregate economic output or well-being of society. Economic impact measures are useful in indicating the potential impact of a specific project on employment and income, in indicating impacts in specific downstream industries, and in the regional distribution of impacts.

For both types of analysis, two main interest groups exist -- the local region (i.e., the region in which the project is undertaken) and the province. Economic value and impacts accruing to local residents or agencies operating in the local region only are included in the local regional analysis. Economic values and impacts accruing to all Ontario residents are included in the provincial analysis.

Conceptual frameworks for analysis for both components are presented. The conceptual frameworks developed must be modified to conform to data availability. The resulting operational frameworks can then be implemented for specific lake reclamation projects on West, Rice, Three Mile, Vernon, Mary, and Fairy Lakes (see Section 7.0).

5.1 Economic Value of Changes in Recreation Quality

5.1.1 The Concept of Economic Value

Economic value or welfare benefits of recreation represent the net increase in final goods and services available for consumption by society attributable to recreation activity.[1] Sometimes these net benefits are called primary economic benefits or economic efficiency benefits.

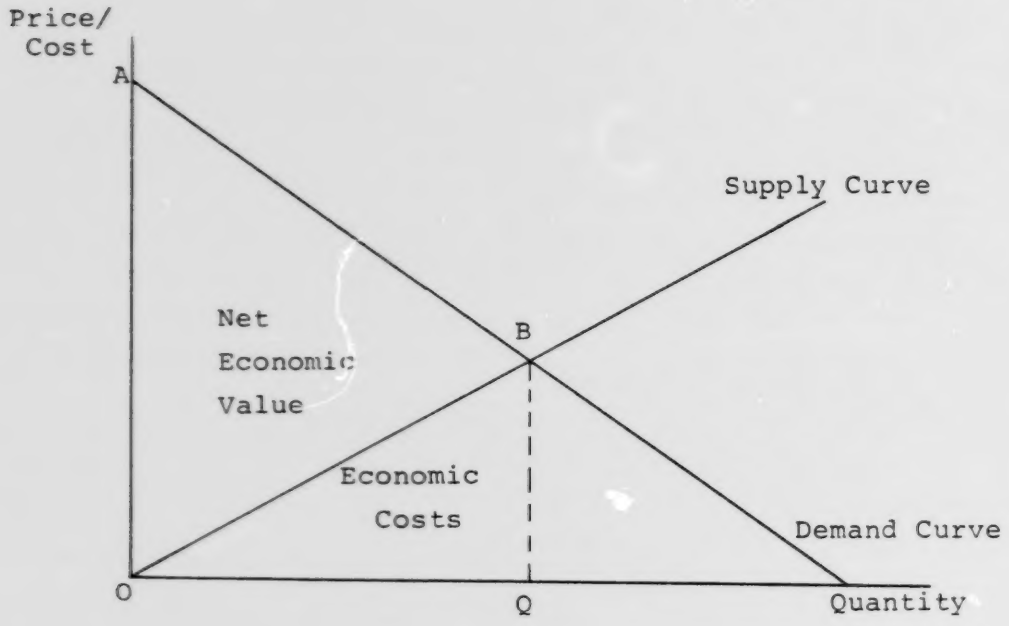
The economic value of a good or service equals gross benefits less full economic costs. The gross benefits of a good or service represents the satisfaction or utility obtained from the good or service. Gross benefits are measured by the maximum amount of money final consumers are willing to pay.[2] A demand curve shows these maximum amounts for given quantities of output. Total gross benefits of Q units are measured by the area under the demand curve up to the point Q or area OABQ in Exhibit 5.1.

Economic costs represent the opportunity costs of material and service inputs, labour, capital, and raw resources in their best alternative use.[3] Opportunity, and hence, economic costs reflect the concept that using resources for one purpose precludes their use to generate benefits in other uses.

A supply curve shows the minimum amount producers would have to receive in order to supply a given quantity of product. Essentially, the supply curve represents the production cost curve, including opportunity costs of capital and labour employed. Full economic costs of Q units are measured by the area under the supply schedule, or OBQ in Exhibit 5.1.

Subtracting full economic costs from gross benefits leaves the area above the supply curve and below the demand curve -- area OAB in Exhibit 5.1. This area represents the economic value of Q units.

EXHIBIT 5.1: MEASURE OF ECONOMIC VALUE



The economic value of aquatic-based recreation is the value of the recreation "experience" as measured by recreation days. A recreation day consists of the participation by one individual in recreation activities for all or any reasonable portion of a 24 hour period.

In the terminology used above, the gross benefit of the recreation experience is the maximum price (cost) recreationists are willing to pay (incur) for that experience. This maximum price is sketched out by the demand curve for recreation days. The cost of participating in recreation represents the implicit "price" of a recreation day. These costs include travel time, equipment, food, etc. The difference between willingness to pay and the price is the economic value of recreation, also referred to as consumer surplus.[4,5]

5.1.2 Measuring Recreation Values

Three unique issues arise in determining the economic value or consumer surplus of recreation activity:

- the use of values for non-market outputs (imputed values);
- the utilization of alternative value concepts depending on whether a resource use opportunity is being provided/enhanced or taken away/harmed (willingness to pay versus compensation required);
- the recognition of three distinct values that comprise the total value of a recreation opportunity (use, option, and existence values).

Imputed Value of Recreation Activity

The gross economic value of any good or service is determined by the amount of money people are willing to pay for it.

This value, in turn, is generally a function of the enjoyment people receive from the good and its relative scarcity. For privately-supplied goods, market determined prices provide a reasonable indication of what people are willing to pay.

However, for publicly-supplied goods and services, such as aquatic-based recreation in Ontario lakes, no competitively determined market price exists. Therefore, to determine the value of publicly-funded recreation, imputed market methods have been developed to estimate appropriate monetary values (e.g., travel cost, contingent valuation, hedonic[6], Talhelm approach[7]).

Willingness to Pay Versus Compensation Required

In theory, the appropriate measure of the economic value of recreation activity depends upon whether one is gaining or losing recreation opportunities, i.e., whether one owns rights to the recreation opportunities. When receiving an opportunity, such as improvements in environmental quality, value is measured by the amount people are willing to pay for that opportunity -- i.e., willingness to pay. When an opportunity is being taken away, as may occur with environmental degradation, the appropriate value is the amount people must receive as compensation for losing the opportunity and still feel as well off as before -- i.e., compensation required.[8]

The difference between the two measures has frequently been assumed to be negligible and willingness-to-pay measures have been used as proxies for compensation required. However, several researchers have undertaken tests involving real cash exchanges that indicate that compensation required measures exceed willingness to pay measures for the same good or service.[9] That is, people appear to value one unit of a good or service that is taken away more than they value receiving one additional unit of the same good or service.

Knetsch[10] suggests that the discrepancy is caused by "framing effects" which arise from differences in the point of reference for evaluation. The willingness to pay measure requires a sacrifice of currently held income. Money offered as compensation, on the other hand, is considered a gain and is not valued as highly.

Put simply, "the pleasure of winning a sum of money is much less intense than the pain of losing the same sum" -- i.e., it depends on whether one is giving up something previously owned or gaining something owned by others. If one is giving up something previously owned, one essentially is "selling" something -- one is operating from a supply curve. If one is buying something previously unowned, one essentially is "buying" something -- one is operating on a demand curve.[11]

Lake reclamation projects enhance recreation opportunities. The appropriate value measure for assessing the benefits of reclamation, therefore, is willingness-to-pay.

Use, Option and Existence Values

Discussion of the economic value of recreation opportunities and resources so far has referred to use value -- the economic value resulting from the enjoyment of actually using the resource. There are two classes of non-user values which reflect value in (i) potential personal use, and (ii) the preservation of recreation opportunities for others.

Benefits that non-users obtain through knowing they have the opportunity or option to use the resource in the future are called option values.

Benefits associated with the knowledge or satisfaction that recreation resources are being preserved for present and future enjoyment by others -- even if the individual is not going to use the resource in the future -- are called existence values.[12]

The relative importance of option and existence values to total (use plus option plus existence) value depends on the features of the resource opportunity under consideration. For very unique recreation resources, such as the Grand Canyon, option and existence values may be much more important than is use value. For non-unique recreation resources having many substitutes, such as a prairie slough, option and existence values may be zero.

It is likely that option and existence values will not change drastically because of lake reclamation initiatives, as there is a vast array of Ontario lakes which provide recreation substitutes. In this study, therefore, the framework for estimating the recreation values of specific lake reclamation projects captures use values only.

5.1.3 The Recreation Demand Curve and Changes in Recreation Quality[13]

The recreation demand curve is the key underpinning in determining the economic value of recreation quality improvements. Any change in the demand curve for recreation will affect the economic value of recreation opportunities. A demand curve in its simplest form shows the maximum amount consumers are willing to pay for given quantities of the same quality output. That is, product (water) quality is the same at all points on the same demand curve.

For any given lake, there is a whole family of demand curves with the position of each curve depending on overall lake water quality (all else remaining the same). As water quality improves, it enhances the quality of the recreation experience on the lake and, one would expect, increases recreation use -- i.e., the demand curve shifts to the right. In this way, water quality represents a demand "shifter".

The proposed economic value framework or demand function appropriate for estimating the benefits of aquatic-based recreation at a specific site is:

$$R = f[P, I, P_s, C, q_s, q_1(E_1), q_2(E_2), q_3(E_3)] \quad (1)$$

where

- R = quantity demanded of recreation days (fishing plus swimming plus boating)
- P = implicit "price" of the recreation activity
- I = income (and other socio-economic characteristics)
- P_s = price of substitutes to recreation at the lake
- C = crowding
- q_s = on-shore site quality features and services available
- $q_1(E_1)$ = recreational fishing quality factor linked to lake biophysical parameter E_1
- $q_1(E_2)$ = recreational swimming quality factor linked to lake biophysical parameter E_2
- $q_3(E_3)$ = recreational boating quality factor linked to lake biophysical parameter E_3

The "price" of recreation is the sum of expenditures to get to and from the site (i.e., travel costs), expenditures on accommodation, food, equipment and so on, the imputed value of time in travel and on-site, any direct entrance/parking fees, and other items. That is, the price of recreation is the cost of participation.

Income and other socio-economic characteristics, such as education, of potential recreationists affect the level of recreation demand on a particular lake.

The "price" and availability of substitute recreation lakes and activities affects the demand for recreation at a particular lake. Note that the economic value of recreation at a lake having several nearby substitute lakes for recreation (i.e., P_s is low) would be lower than if the

closest substitute lakes were a considerable distance away (i.e., P_s is high), everything else being equal.

The appeal of any particular lake will, after a certain point, be compromised by crowding. Crowding may be viewed as a limiting factor on increasing demand.

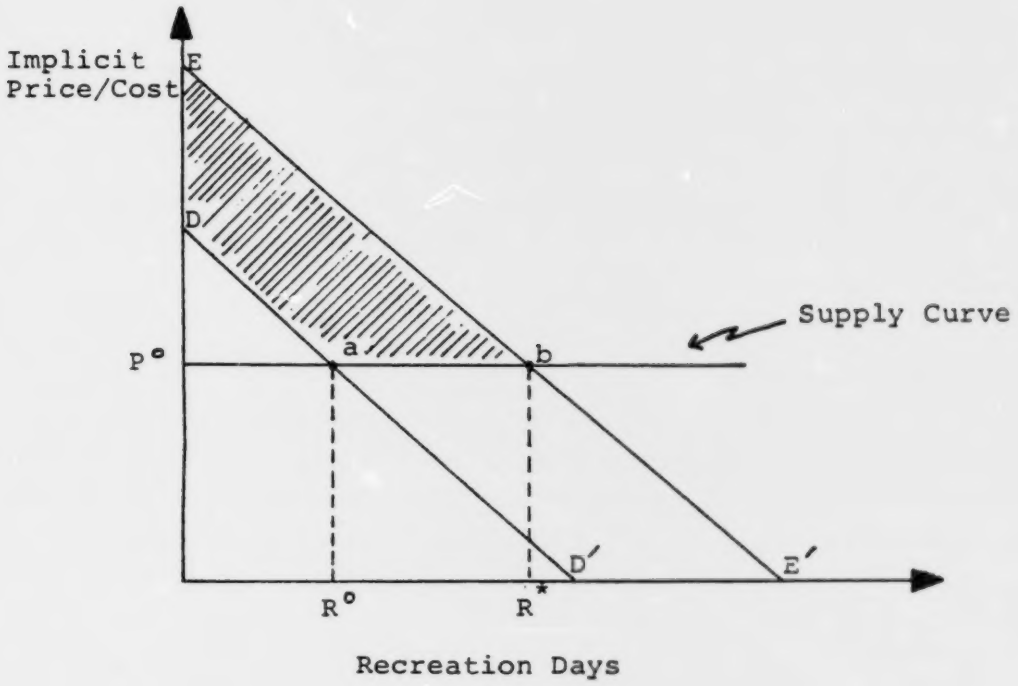
The proposed demand formulation separates out on-shore site quality features and services, such as the amount of accommodation and parking available, from water-related quality features such as angling catch rates and water quality. Recreation use of a lake is affected by the amount and quality of on-shore services. In extreme cases of excess demand, on-shore facilities can represent a constraint on the level of recreation utilization of a lake.

The last three factors in the demand equation -- $q_1(E_1)$, $q_2(E_2)$, $q_3(E_3)$ -- capture the effect of changes in water quality on recreation demand: changes in water quality affect the biophysical parameters (E_1, E_2, E_3) which then change the attractiveness of the lake for recreation activities and, ultimately, demand.

The analysis of Section 4.0 suggests the following linkages between recreation activity and biophysical parameters:

Activity	Main Recreation Quality Factor	Biophysical Parameters
fishing	<-------- catch rates preferred species	<----- MEI/phosphorus concentration
swimming	<-------- water clarity (Secchi depth)	<----- chlorophyll *a* concentration
boating	<-------- lack of aquatic plant growth	<----- chlorophyll *a* concentration

Exhibit 5.2: ILLUSTRATION OF DEMAND SHIFT WITH A CHANGE IN RECREATIONAL QUALITY



D, D′ - Original demand curve

E, E′ - New demand curve as a result of change in recreation quality (i.e., supply curve does not change)

If one or more recreation quality factors improves, the demand curve will shift outwards and recreation activity will increase (provided the lake site is not constrained with respect to services).

Changes in economic values associated with this demand shift can be illustrated graphically. Exhibit 5.2 represents the recreation demand and supply curves for a specific site in a partial equilibrium framework. Under present environmental conditions, the recreation demand curve on a lake is DD'. The supply curve is horizontal at P^{o} -- the average price of a recreation day.[14] The amount of recreation activity is R^{o} recreation-days, i.e., the point where marginal benefit equals marginal cost or price. (Note: Both the demand and supply curves are drawn as straight lines for illustrative purposes only.)

Under initial environmental conditions, recreationists reap a consumer surplus of area $P^{o}Da$ -- the difference between what they are willing to pay and what they actually have to pay for quantity R^{o}. The area $P^{o}Da$ is the net economic value of R^{o} recreation days.

Now suppose a lake reclamation activity is undertaken that enhances one or more recreation quality feature(s). The demand curve shifts outward to EE'. (The horizontal supply curve does not change.) The amount of recreation activity increases to R* recreation days. The new consumer surplus (economic value) is the area $P^{o}Eb$.

The change in consumer surplus or economic value due to the change in recreation quality is the area DEba.

The foregoing discussion and Exhibit 5.2 refer to an economic value framework for a single site/lake. The quantity of recreation refers to recreation days per unit time, in this case a year. Accordingly, the economic value represents an annual net benefit.

5.1.4 An Operational Economic Framework

Primary (survey) data required to estimate the demand curve specified in equation (1) above are not available for any of the six lakes under study. However, one does not necessarily need to model the entire demand curve to estimate recreation quality impacts.[15] One can employ a proxy procedure.

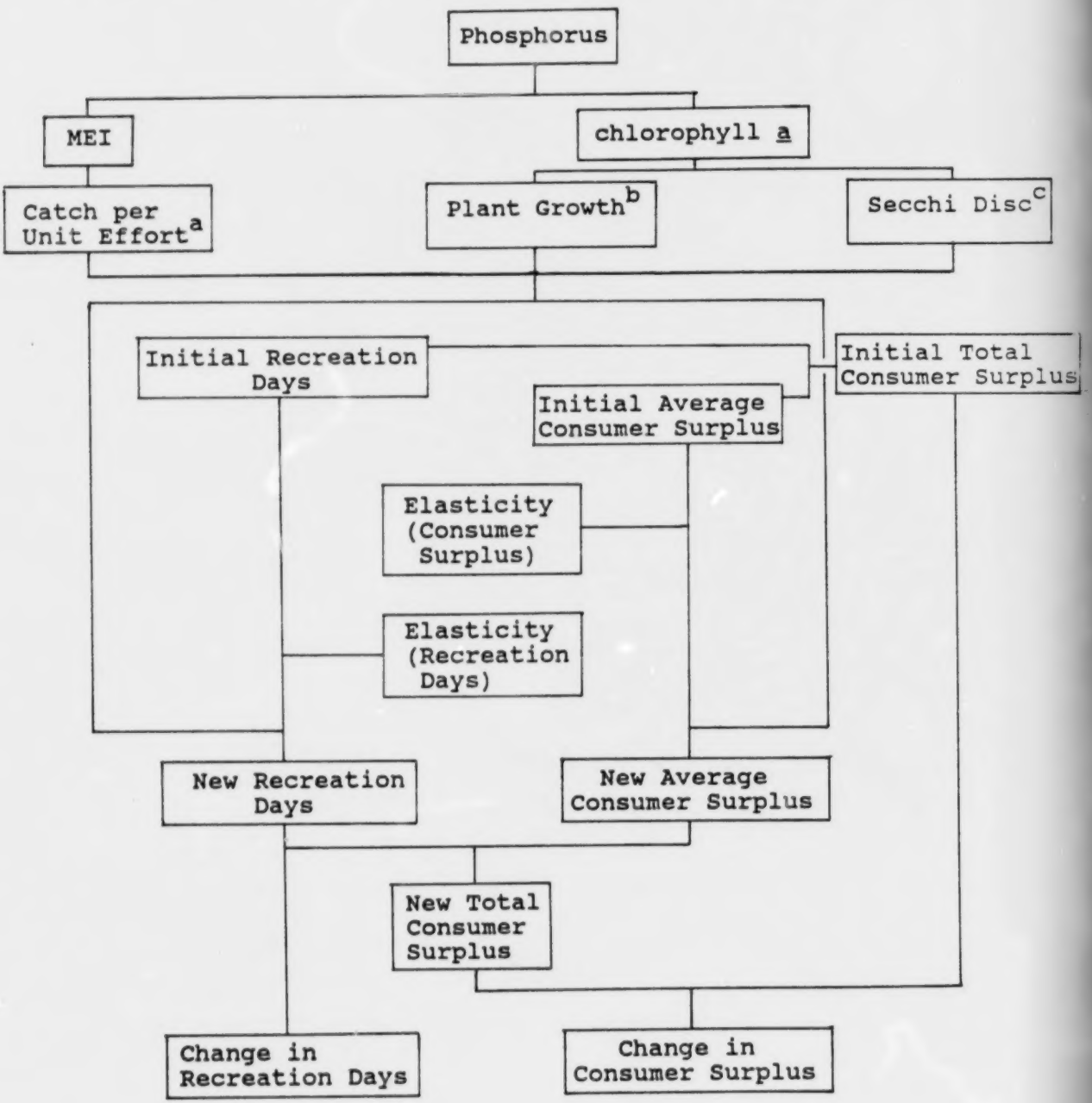
The operational framework for estimating changes in economic value is summarized in Exhibit 5.3. Changes in phosphorus change water quality parameters and, hence, recreation quality parameters (catch per unit effort, plant density, Secchi disc readings as a measure of water clarity). Changes in water and recreation quality parameters are calculated using the equations in Section 4.4.2.

Changes in recreation quality affect both average consumer surplus and number of recreation days according to estimates of elasticities (i.e., responsiveness to changes in recreation quality). Total consumer surplus (average consumer surplus times recreation days) is calculated for both initial environmental conditions and improved water quality. The difference in the two total consumer surplus figures is the change in economic value.

Inferences about changes in economic value (consumer surplus) can be made using (1) empirically derived estimates of average economic value per recreation day, (2) the present level of recreation use in the lake, (3) estimates of the responsiveness of the change in recreation days due to a change in recreation quality, and (4) estimates of the responsiveness of the change in average value per day due to a change in recreation quality.

The change in consumer surplus (area DEba of Exhibit 5.2) can be calculated as the difference in consumer surplus before and after the change in water quality, or:

EXHIBIT 5.3: FRAMEWORK FOR ESTIMATING CHANGES IN ECONOMIC VALUES



Notes:

MEI Morphoedaphic index
a Quality parameter for fishing
b Quality parameter for boating
c Quality parameter for swimming

$$\Delta CS = CS' - CS^{o} \qquad (2)$$

where

ΔCS is the change in consumer surplus

CS' is consumer surplus after a change in water quality

CS^{o} is consumer surplus before a change in water quality.

The original consumer surplus, CS^{o}, is the product of average consumer surplus per day and number of recreation days before the change, or

$$CS^{o} = S^{o} * R^{o} \qquad (3)$$

where

S^{o} is average consumer surplus per day before a change in water quality

R^{o} is average number of recreation days before a change in water quality

Estimates of average consumer (S^{o}) and recreation days (R^{o}) before a change in water quality are available from original data collection and the review of the literature on recreation values. Estimates used in this study are documented in Section 6.0.

Consumer surplus after a water quality change is calculated using an analogous method:

$$CS' = S' * R' \qquad (4)$$

The new average consumer surplus (S') and new recreation days (R') are calculated from the initial values by applying elasticities. An elasticity measures the responsiveness of one variable to changes in another. In this case, two elasticities are required -- one which relates changes in water quality to changes in average (daily) consumer surplus and one which relates changes in water quality to changes in recreation days. With this information, equation (4) can be rewritten as:[16]

$$CS' = S^{o} * [(e_S * \% \text{ change in water quality parameter})/100 + 1] * R^{o} * [(e_R * \% \text{ change in water quality parameter})/100 + 1] \quad (5$$

For example, a recreation activity elasticity (e_R) of .1 would imply that a 10% change in recreation quality would give rise to a 1% change in recreation days.

One then can calculate the change in consumer surplus ΔCS (as $CS'-CS^{o}$). This calculated change in consumer surplus based on elasciticies is equivalent to the change in consumer surplus as represented by the difference in areas under the two demand curves (area DEba) of Exhibit 5.2.

Estimates of elasticities for both average daily consumer surplus and recreation days are drawn from the literature (see Section 6).

Changes in water quality parameters are determined by changes in phosphorus through the equations given in Section 4.4.2. Phosphorus control is the lake reclamation initiative chosen for empirical study in this project.

5.2 Economic Impact of Changes in Recreation Quality

5.2.1 The Concept of Economic Impacts

Economic impacts of recreation refer to the expenditure, income and employment impacts associated with a change in recreation activity. Economic impacts are sometimes called secondary economic benefits.

Income and employment impacts are derived from the stimulus in expenditure. Income is defined as value added, (or the gross return to capital and labour), and includes profit, taxes, interest payments, a factor for depreciation, as well as salaries and wages.

Income and employment effects provide a gross measure of impacts in that the alternative uses of capital and labour in the economy are not subtracted out as an opportunity cost. Labour and capital employed in recreation supply industries would, to a large extent, earn a return elsewhere in the economy if the recreation activity did not exist. As a result, labelling income and employment economic impacts as benefits can be misleading.

An income or employment economic impact in one industry may be counterbalanced by income or employment losses in other industries, depending on the level of unemployment in the economy and the need for the expenditure giving rise to the impact. Public investments which improve economic efficiency generally are preferable to those which simply raise the level of economic activity, because improved efficiency expands the output potential for the economy as a whole.

Economic impact analysis, nevertheless, is useful in assessing the regional development and employment generation consequences of an autonomous/incremental increase in recreation expenditures. It is most useful in a comparative analysis situation where one can investigate the relative ranking of income and employment associated with each industry sector and across regions.

5.2.2 Incremental Economic Impacts

The assessment of economic impacts of lake reclamation projects is undertaken for two geographic groups: the local region and the Province of Ontario. Although improvements in water quality will lead to increased lake recreation activity and expenditures, only expenditures which are **incremental** to the geographic region (i.e., local region or province) will generate employment and income impacts. Incremental expenditures are those which would not have occurred within the region without the lake reclamation project.[17]

It is difficult to identify the portion of expenditures which is incremental. For example, changes in spending by residents of the local region may or may not generate local employment and income impacts. Changes in resident expenditures would not be considered incremental if they represent diversion of spending from other recreational activities (or purchases of goods and services) elsewhere in the local region. Changes in spending by local residents would be considered incremental if local recreationists would otherwise have spent the money outside the region (e.g., boating on a lake in a neighbouring county).

For this study, incremental expenditures are deemed to be those associated with incremental recreation days (due to the change in lake water quality). Only recreation days by non-locals are included. It is probable that recreation expenditures by locals simply represent a reallocation of disposable income that would have been spent in the local region without the change in water quality.

5.2.3 The Economic Multiplier Framework

It is conventional to include three levels of economic impacts associated with projects like lake reclamation initiatives.[18] The three components are:

- direct impacts;
- indirect impacts; and
- induced impacts.

An initial expenditure results in value added (wages and salaries plus gross capital returns) accruing to direct industry participants. The value added of the industry participants plus the value added of their direct suppliers is termed the direct income impact. Direct impacts would, therefore, include income at resorts, restaurants or stores at which recreationists purchase goods and services.

However, the economic expansion associated with an initial cash expenditure goes beyond this direct impact. The initial expenditures are respent by their recipients and this respending goes through a number of iterations by the firms that supply these second stage suppliers and so on. Indirect impacts refer to income and employment generated by firms that supply the recreation service industry. In our example, indirect employment would include employment generated by the food producers who supply restaurants.

Finally, induced effects are the additional employment and income generated by consumption spending of those directly and indirectly employed as a result of greater recreation activity. Spending and respending of income results in employment and income in the retail, service and consumer industries.

The total magnitude of income and employment impacts depend on the absolute level of incremental expenditures and the economic structure of the region of interest. The magnitude of indirect impacts, for example, will depend on the proportion of supplies to resorts, restaurants, etc. that can be purchased from local producers. Similarly, induced impacts will depend on the proportion of goods and services at the retail and service levels that can be locally supplied.

If most goods and services must be brought into the region, there is a high import content of recreation expenditures. Imports (as well as taxes and savings) represent leakages from the regional economy, and reduce the base from which employment and income impacts are generated.

For example, the magnitude of the indirect and induced effects for any dollar of incremental expenditure will be smaller for the local region than for the province as a whole. At the provincial level, the economy is large, diversified, and capable of producing many goods and

services. At the local level, the demand for goods and services must be met by importing from outside the region; there are greater leakages and less money remains in the local region to generate employment and income.

Analagous to income impact generation, an expenditure stimulus results in direct, indirect and induced employment impacts.

Economic impacts are calculated using a simple Keynesian type (consumption) multiplier as outlined in Appendix K.[19]

The approach involves three main steps (see Exhibit 5.4):

(1) Estimate incremental expenditures (incremental recreation days x average expenditure per recreation day).

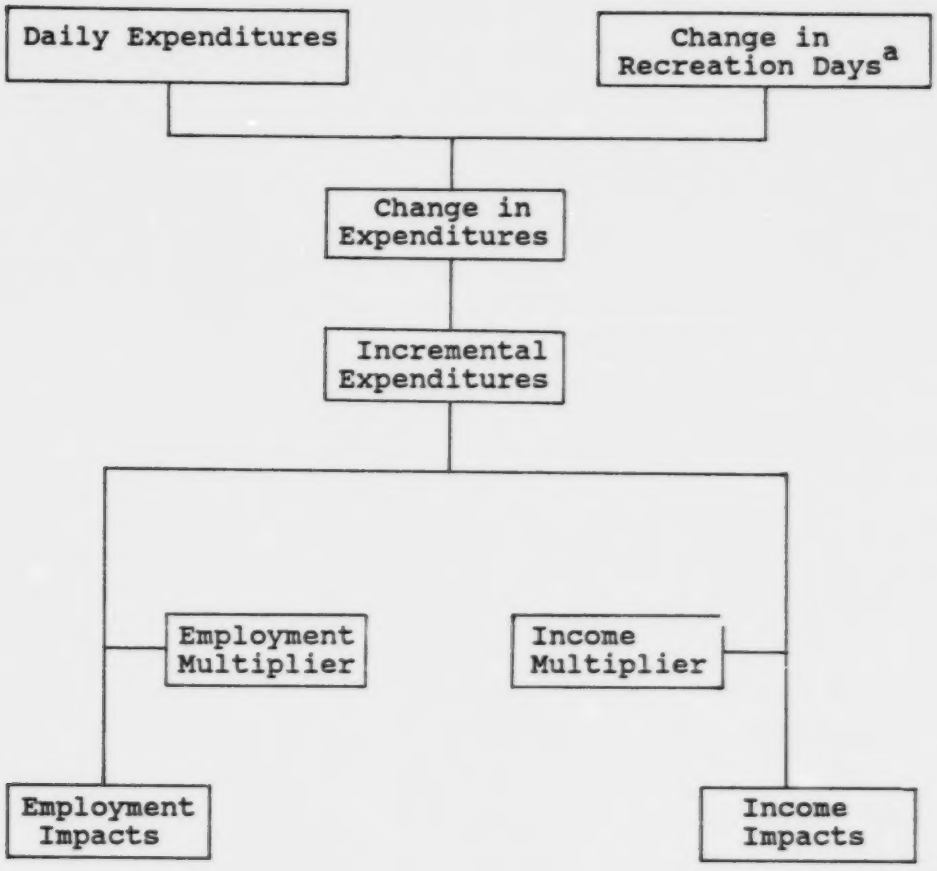
(2) Apply a standard regional income multiplier to the incremental expenditure level to estimate the total income (value added) impact.

(3) Apply a standard regional employment multiplier (full time jobs per $100,000 expenditure) to the incremental expenditure level to estimate total employment impacts.

These three steps are required at both the local region and provincial levels as incremental expenditures and income and employment multipliers differ between the two regions.

Data required to implement this operational approach are presented in Section 6.0.

EXHIBIT 5.4: FRAMEWORK FOR ESTIMATING ECONOMIC IMPACTS



[a] From economic value analysis (Exhibit 5.3)

5.3 An Illustrative Example -- Fishing Activity in Rice Lake

Changes in sport fishing economic value and economic impacts associated with a 25% reduction in phosphorus in Rice Lake are outlined in this section. The intent is to demonstrate the procedures outlined in Sections 4.1.4 and 5.2.3. Intermediate calculations and results are reported in Exhibits 5.5 and 5.6. Sources for parameter values are given in Section 6.0 following.

The 25% reduction in phosphorus results in an estimated 57.5% decrease in the MEI (according to equation (1), Section 4.4.2). This, in turn, results in a decrease in total fish biomass of 31.7% (equation (2), Section 4.4..2). At the same time, the proportion of preferred species in total fish biomass is projected to double (according to equation (3), Section 4.4.2). The combined effect is a 36.6% increase in the biomass, and hence catch per unit effort, of preferred species.

Based on a catch success elasticity of 0.10 with respect to fishing activity, this 36.6% change in CPUE is estmated to result in 3.66% or 22,400 more angler days. Based on a catch success elasticity of 0.15 with respect to fishing economic value (or consumer surplus) per angler day, this 36.6% change in CPUE is estimated to result in a 5.49% increase in the average value of an angler day.

Total economic value to local Rice Lake residents increases by by $33,000. The increase in economic value to provincial residents of $741,000 is much larger, since it includes other Ontario resident economic value.

The 22,400 additional angler days result in incremental expenditures of $815,000 to the local region and $433,000 to the province. Incremental expenditures are higher at the local area since they include local expenditures by other Ontario **and** out-of-province fishermen. Provincial incremental expenditures include only provincial expenditures

EXHIBIT 5.5: ECONOMIC VALUE AND ECONOMIC IMPACTS CALCULATIONS FOR A 25% REDUCTION IN PHOSPHORUS -- FISHING ACTIVITY AT RICE LAKE

	BEFORE	AFTER	CHANGE
BIOPHYSICAL PARAMETERS			
Phosphorus	41.3		-25.0%
Total Fish Biomass			-31.7%[a]
Prop. Preferred Species in Biomass			+100.0%[b]
CPUE of Preferred Species			+36.6%[c]
RECREATION DAYS ('000)			
Local Residents	34.8	36.1	1.3[d]
Other Ontario Residents	378.8	392.7	13.9
Out-of-Province Residents	197.1	204.3	7.2
Total	610.7	633.1	22.4
ECONOMIC VALUE PER DAY ($)			
Local Residents	10.0	10.55	0.55[e]
Other Ontario Residents	20.0	21.10	1.10
DAILY EXPENDITURES ($)			
Other Ontario			
Day User	35.0		
Overnighter	60.0		
Cottager	25.0		
Out-of-Province Residents	60.0		
DISTR. OTHER ONTARIO RESIDENTS BY TYPE			
Day User	0.005		
Overnighter	0.537		
Cottager	0.458		
LOCAL SHARE EXPENDITURES			
Other Ontario Residents			
Day User	0.5		
Overnighter	0.8		
Cottager	0.7		
Out-of-Province Residents	0.8		
TOTAL ECONOMIC VALUE ($000)[f]			
Local Residents	348.0	380.6	32.6
Other Ontario Residents	7576.0	8284.8	708.8
TOTAL EXPENDITURES ($000)			
Local Area			
Other Ontario Residents			470.0[h]
Out-of-Province Residents			346.5[g]
The Province			
Out-of-Province Residents			433.1[i]

a From equations (1) and (2), Section 4: $(1 - 0.25 \times 2.3)^{0.4451} = 0.683$

b Equation (3), Section 4: $0.25 \times 4.0 = 1.00$

c Equation (4), Section 4: $0.683 \times 2 = 1.366$

d Recreation days elasticity of 0.10. So 36.6% change in CPUE gives rise to $0.10 \times 36.6\% = 3.66\%$ change in recreation days.

e Economic value elasticity of 0.15. So 36.6% change in CPUE gives rise to $0.15 \times 36.6\% = 5.49\%$ change in recreation value per day.

f Recreation days x economic value per day.

g Change in recreation days x daily expenditure x local share.

h Change in recreation days x prop. type i x daily expenditure for type i x local share, summed over the three types (day user, overnighter, and cottager), i.e., $(13.9 \times 0.005 \times 35 \times 0.50) + (13.9 \times 0.537 \times \ldots)$

i Change in recreation days x daily expenditure.

by out-of-province anglers. In the analysis it is assumed that expenditures by other Ontario anglers simply represent a reallocation of expenditures from other areas of the province to the local area (see Section 5.2.2).

EXHIBIT 5.6: ANNUAL ECONOMIC IMPACT VALUE AND INCOME AND EMPLOYMENT IMPACTS FOR FISHING ACTIVITY FROM A 25% REDUCTION IN PHOSPHORUS IN RICE LAKE

	REGION	
	LOCAL AREA	PROVINCE
CHANGE IN ECONOMIC VALUE ($000)	33[a]	741[b]
ECONOMIC MULTIPLIERS[c]		
Income Multiplier	0.70	1.25
Employment Multiplier	0.028	0.05
ECONOMIC IMPACTS		
Incremental Expenditures ($000)	816[d]	433[e]
Income Impacts ($000)[f]	571	541
Employment Impacts (jobs)[g]	23	22

[a] Change in economic value of local residents (Exhibit 5.5).
[b] Change in economic value of local and other Ontario residents (Exhibit 5.5).
[c] Appendix K.
[d] Change in expenditures by other Ontario and Out-of-Province residents (Exhibit 5.5).
[e] Change in expenditures by Out-of-Province residents (Exhibit 5.5).
[f] Incremental expenditures x income multiplier.
[g] Incremental expenditures x employment multiplier.

Estimated income and employment impacts in the local Rice Lake area are $571,000 and 23 person-years of employment (Exhibit 5.6). Corresponding impacts at the provincial level are $541,000 and 22 person-years of employment.

FOOTNOTES

[1] A basic premise of economics is that activities only have value through the additional consumption opportunities they provide. Consequently, the appropriate reference point for valuation is the final consumer level.

Province of British Columbia, "Guidelines for Benefit-Cost Analysis" by Vernon W. Loose, Environment and Land Use Committee Secretariat, Victoria, June, 1977, pg. 7-8.

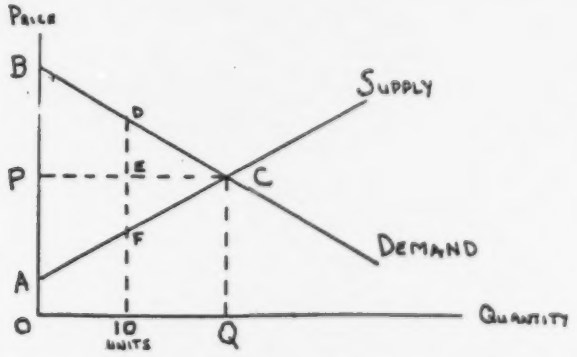
[2] Ibid. pg.17.

W.H. Desvousges and V.K. Smith, Benefit-Cost Handbook for Water Programs Volume I, Report prepared for the U.S. Environmental Protection Agency, Research Triangle Institute, Research Triangle Park, North Carolina, April 1983, p.1-4 to 1-5.

U.S. Water Resources Council, Manual of Procedures for Valuing the NED Recreation Benefits and Costs of Federal Water Resources Projects, January 1979, p. 3.

[3] E.J. Mishan, Elements of Cost-Benefit Analysis, George Allen & Unwin, London, 1976, p. 13.

[4] Net economic value for most goods and services is enjoyed by both consumers and producers. Consumers receive **consumer surplus**, which is the maximum amount a person is willing to pay for a commodity over and above the prevailing price. This amount is shown as the distance DE for 10 units in the graph below. Total consumer surplus is the sum of corresponding distances for each unit purchased, or the area PBC in the graph.



Producers receive producer surplus, which is defined as the amount the producer receives for a good over and above the minimum cost of supplying it. It is given as the distance between the supply and price curves or the distance EF in the above graph. Total producer surplus(analogous to total consumer surplus) is the area APC.

The economic value of a good or service is the sum of producer and consumer surpluses, or the area ABC.

In contrast to most goods and services, the recreation experience represents a joint activity by a single individual or household. In essence, the household is both consumer and producer (through use of time, equipment, available recreation sites and other inputs) of the recreation experience. For recreation, then, producer and consumer surpluses are indistinguishable. For convenience, the single term "consumer surplus" will be used. (This household production approach or rationale is elaborated upon in: Timothy A. Deyak and V. Kerry Smith, "Congestion and Participation in Outdoor Recreation: A Household Production Approach", Journal of Environmental Economics and Management, Vol. 5: 63-80, March 1985; and W.J. Vaughan and C.J. Russell, "Valuing a Fishing Day: An Application of a Systematic Varying Parameter Model", Land Economics, Vol. 58, No. 4, November 1982.)

[5] The economic value framework discussed here is taken from the perspective of the household. The Province of Ontario, as owner of the lakes in Ontario, incurs a cost in maintaining, monitoring, etc. lakes under its domain. As well, the use of a lake for recreational purposes may preclude using the water, fish, plant and wildlife resources of that lake for other purposes (e.g., commercial fishing or agriculture). The opportunity cost of the lake resource as well as the government resource management costs represent costs to society but do not represent costs to individual recreationists.

The focus of this study is directed towards "recreation benefits" arising from the reclamation of environmentally impaired lakes i.e., the benefit side only. Government costs and natural resource opportunity costs are therefore external to this inquiry. They are, however, pertinent to a full benefit-cost analysis of the use of a lake for recreation purposes (Desvousges and Smith, op. cit. p. 1-5).

[6] For discussion of various techniques see:

Desvousges and Smith, op. cit.

U.S. Water Resources Council, op. cit.

Andrew Berczi, "Estimating the Economic Consequences of Acid Rain on Sport Fishing -- An Overview", Proceedings of the Acid Rain Evaluation Seminar, Ed. by R.V. Hartley and R.Z. Rivers, Canadian Special Publication of Fisheries and Aquatic Sciences 90, Ottawa 1986, pp. 46-51.

John F. Dwyer, John R. Kelly and Michael D. Bowes, Improved Procedures for Valuation of the Contribution of Recreation to National Economic Development, Report prepared for the U.S. Department of the Interior, Office of Water Research and Technology, September 1977.

Energy and Resource Consultants Inc. Valuing Marine Recreational Fishing on the Pacific Coast, Report prepared for National Marine Fisheries Service, NDAA, March 1985.

[7] A variation of the travel costs procedure -- the so called "Talhelm approach" -- has been applied to estimating the changes in value (consumer surplus) arising from acid rain in the Haliburton/Muskoka region of Ontario. References are:

Victor and Burrell, "An Economic Assessment of Acid Rain Impacts on Sport Fishing in the Haliburton/Muskoka Region", Report prepared for the Department of Fisheries and Oceans, January 1983.

D.R. Talhelm, "Estimating the Values of Potential Acid Precipitation Damages to Sport Fisheries in Canada. The Talhelm Approach: Advantages and Disadvantages", Proceedings of the Acid Rain Evaluation Seminar, Ed. by R.V. Hartley and R.Z. Rivers, Canadian Special Publication of Fisheries and Aquatic Sciences 90, Ottawa 1986, pp. 61-63.

[8] Ontario Ministry of the Environment, The Economics of Acid Precipitation: A Review of Socio-Economic Methods to Assess Acid Deposition Effects, Corporate Policy and Planning Branch, January 1986, pp. 7-8.

Desvousges and Smith, op. cit. p.1-5.

[9] Jack Knetsch, Property Rights and Compensation: Compulsory Acquisition and Other Losses. Butterworths, 1983, Chapter 3.

Richard C. Bishop and Thomas A. Haberlein, "Simulated Markets, Hypothetical Markets, and Travel Cost Analysis: Alternative Methods of Estimating Outdoor Recreation Demand", Technical Report No. 187, Department of Agricultural Economics, University of Wisconsin, December, 1980.

[10] Knetsch, op. cit.

[11] Talhelm, op. cit.

[12] Ontario Ministry of the Environment, op.cit. pg.8.

D.A. Greenley, R.G. Walsh and R.A. Young, Economic Benefits of Improved Water Quality: Public Perceptions of Option and Preservation Values, Studies in Water

Policy and Management, No. 3, Westview Press, Boulder, Colorado 1982.

[13] Alternate demand formulations are discussed in Appendix I.

[14] Deyak and Smith op. cit. show that the individual's supply function for his produced recreation service flows is horizontal (i.e., perfectly elastic) under reasonable conditions.

[15] See Desvousges and Smith, op. cit., p. 3-4, and Water Resources Council, op. cit.

[16] Elasticities are defined as:

$$e_S = \frac{\text{\% change in avgerage consumer surplus}}{\text{\% change in water quality parameter}}$$

The units of the terms including e_S in equation (5), therefore, must be changed (by dividing by 100 and adding 1) before applying them to the initial value for S. An analagous procedure exists for the elasticity e_R.

[17] Incremental expenditures discussed here refer to incremental recreation expenditures. In a comprehensive impact analysis, incremental government expenditures and private sector investment in lake reclamation projects would also be applicable. Government and private expenditures for lake reclamation, however, lie outside the terms of reference for this study.

[18] For descriptions of economic impact analysis in the context of tourism and a specific tourism-related industry, see:

Ontario Ministry of Tourism and Recreation, The Economic Impact of Tourism in Ontario and Regions 1982, Tourism Research Section, June 1984.

D. Topolniski, L. Anderson and K. Daley, An Economic Survey of Saskatchewan's Outfitting Industry, Department of Fisheries and Oceans, Winnipeg, September 1984, Appendix E.

[19] An input-output model approach is preferred. However, no input-putput models exist with respect to the small local regions under survey.

6.0 DATA SOURCES

Reliable data to implement the economic framework outlined in Section 5.0 are not available. Inadequacies exist with respect to both biophysical information (e.g., most recent data for some lakes refers to the year 1972) and economic information (e.g., no Ontario specific data on consumer surplus elasticities). Information gaps are especially acute with respect to swimming and boating recreation activities.

Nevertheless, for illustrative purposes, estimates of required data and parameters for the lakes under study have been made on the basis of available information -- information which largely relates to fishing activity and which largely relates to jurisdictions outside Ontario.

Information is required in seven areas:

- lake biophysical status,
- current level of recreation use,
- consumer surplus per recreation day,
- recreation use elasticities,
- consumer surplus elasticities,
- expenditures per recreation day, and
- economic multipliers.

For each category, estimates, sources and appropriate caveats are presented.

6.1 Lake Biophysical Parameters

Critical data requirements are initial levels of: phosphorus, chlorophyl a, Secchi disc readings, and the morphoedophic index. These data are used to generate initial levels of recreation quality (Section 4.4.2).

Biophysical parameters are drawn from the biophysical inventories in Appendices B through G. The inventories refer to a variety of years. Specific data sources vary, but include Ministry of Natural Resources (MNR) resource maps and computer database, MOE/MNR lake sampling program data sheets, and municipal reports. The biophysical parameters used for this study are given in Exhibit 6.1.

EXHIBIT 6.1: LAKE BIOPHYSICAL PARAMETERS

Biophysical Parameters	Lake					
	West	Rice	Three Mile	Vernon	Mary	Fairy
Phosphorus (u/l)	52.0	41.3	18.0	11.0	7.0	8.0
Morphoedaphic index	49.2	49.0	8.4	1.9	1.1	1.0
Secchi disc (metres)	0.8	1.6	1.3	2.3	2.8	2.7
Chlorophyll *a* (u/l)	11.2	19.1	8.3	1.0	0.9	1.5

Source: Biophysical inventories of appendices B through G.

6.2 Recreation Activity Levels

Existing recreation use is described in detail in Section 3.2 Recreation use data are derived from resort owner and local official surveys, the facility inventory for each lake, and accomodation guides. Details of the methodology used in deriving recreation days are given in Appendix A.

To calculate the effect of changes in recreation quality parameters, data on (initial) recreation days must be disaggregated by type of recreationist (local, other Ontario, out of province) and by activity (boating, swimming, fishing). Disaggregation by type of recreationist is based on survey data. Disaggregation by activity is based on priority use information from the survey. It is emphasized

that these activity breakdowns are approximations and are subject to revisions as user profiles are improved.

Recreation days by non-local Ontario residents must also be broken out into day-users, cottagers, and other overnighters because daily expenditures differ among the types of users. This breakdown is based on data from resort owner and local official surveys, and secondary information.

EXHIBIT 6.1: CURRENT LEVEL OF RECREATION DAYS

	Lake					
	West	Rice	Three Mile	Vernon	Mary	Fa
Recreation Days (000s days)						
Local	30.3	69.6	9.0	28.8	20.8	
Other Ont.	313.4	757.6	152.8	184.5	182.7	
Out-of-province	43.3	394.2	1.2	16.2	16.9	
Total	**387.0**	**1221.4**	**163.0**	**229.5**	**220.4**	
Distribution by Activity (proportion)						
Fishing	0.10	0.50	0.15	0.05	0.03	0
Swimming[a]	0.65	0.25	0.60	0.60	0.60	0
Boating	0.25	0.25	0.25	0.35	0.37	0
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	1.
Distribution of Ontario Residents (proportion)[b]						
Day-User	0.00	0.00	0.00	0.02	0.02	0.
Overnighter	0.86	0.54	0.25	0.62	0.74	0.
Cottager	0.14	0.46	0.75	0.36	0.24	0.
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	1.

[a] Includes general relaxation.
[b] Non-local only
[c] Numbers may not add due to rounding.

Source: Recreation days estimates in Appendices B through G.

6.3 Average Consumer Surplus

Estimates of average consumer surplus have been based on a review of the literature (Appendix J) and judgement as to the relative levels of average consumer surplus across activities. The figures are rough approximations and should be considered illustrative only.

Appropriately derived estimates of average consumer surplus would depend on the unique features of each lake (e.g., catch rates, on-shore facilities, etc.). Due to lack of data, this study assumes the same average consumer surplus (for any one activity) for all lakes.

Victor and Burrell estimated the average consumer surplus per angler day in the Muskoka/Haliburton region in 1981 at $16.66 for non-local residents. This is equivalent to roughly $20 per angler-day in 1985[1]. This value is generally consistent with freshwater fishing consumer surplus estimates from other studies[2].

One would expect average consumers surplus for swimming to be much less than this and for boating to be close to the sport fishing value figure. Boating caters to higher income strata individuals than does swimming, and also requires a much greater expenditure level for participation. Both these factors would suggest that consumer surplus per recreation day is higher for boating than for swimming[3].

For the same reason, one would expect consumer surplus levels for local residents to be less than for other Ontario residents.

Estimates of consumer surplus by activity and residence based on the above factors are given in Exhibit 6.3. below.

EXHIBIT 6.3: AVERAGE CONSUMER SURPLUS (1985 $ PER DAY)

	Residence of Recreationist		
Activity	**Local**	**Other Ontario**	**Out-of-Province**
Fishing	10	20	N/A
Swimming	5	10	N/A
Boating	10	20	N/A

Source: DPA Group Inc. estimates.

No consumer estimates are required for out-of-province recreationists since they lie outside the two referent regions for the study -- the local region and the Province of Ontario.

6.4 Recreation Use Elasticities

Changes in recreation quality will induce changes in the amount of recreation activity. A recreation use elasticity represents the responsiveness of activity levels to different quality levels (Section 5.1.4).

Conceptually, elasticities vary by residence of recreationist, by activity, and by lake. For example, non-local fishermen are likely to be more dynamic, moving from lake to lake as catch rates change. Swimming and boating activity, however, may not be affected until some critical threshold is reached.

For all activities, the responsiveness or elasticities for local recreationists and cottagers are likely to be lower than for other recreationists because they have a fixed investment in facilities at a lake (e.g., cottages) which cannot easily be shifted to other locations.

Finally, elasticities will likely differ across lakes because of the role of lake-specific characteristics. If, for example, a lake is located in a particularly beautiful

setting, fishermen may accept greater reductions in catch rates than they would in less attractive lakes.

Very little information is available on the responsiveness of recreation use levels to changes in recreation quality. Some information on waterfowl hunting suggests a 10% change in the harvest rate will induce a 1% change in hunting days[4]. This recreation use elasticity is used for sport fishing.

As noted above, boating and swimming use levels are expected to be less responsive to changes in quality than sport fishing (at least within a reasonable range of quality). For this study, the following use elasticities are employed

- Fishing - 0.10
- Swimming - 0.05
- Boating - 0.05

For example, a 10% change in boating quality is projected to induce a 1/2% change in boating activity.[5]

Thew above values are used for all six lakes over all classes of recreationists by residence (local, rest of Ontario, out-of-province). This path reflects information contraints.

6.5 Recreation Value Elasticities

Changes in recreation quality will induce changes in the value (consumer surplus per day) of the recreation activity. That is, changes in recreation quality will cause changes in the level of satisfaction with the recreation experience. A measure of the responsiveness of the change in satisfaction or consumer surplus is the recreation value elasticity (Section 5.1.4).

As was the case with recreation use elasticities, no recreation value elasticities exist for the six lakes under study, for swimming or boating for any lakes in Ontario, or

differentiated by residence of recreationist. Accordingly, recreation value elasticities are disagregated by activity only for this study.

Based on a literature survey of other studies (Appendix J), a sport fishing recreation value elasticity of .15 is used in this study. That is, a 10% change in sport fishing quality/success rates is projected to induce a 1.5% change in sport fishing value (consumer surplus) per day.

Elasticities for swimming and boating are expected to be lower than for fishing since changes in turbidity and weed growth are not as easily detected as are changes in fishing success rates (Section 4.3).

For this study, the following recreation value elasticities are employed:

- Fishing - 0.15
- Swimming - 0.10
- Boating - .10

Recreation value per day is projected to be more sensitive to recreation quality than is the amount of recreation activity (Section 6.4).

6.6 Daily Expenditures

Daily expenditures differ by activity and residence of recreationist. Expenditures may also vary slightly across individual lakes, but assuming the same expenditure values for all lakes is not likely to introduce significant error. Data on daily expenditures are more readily available from published sources than data on average consumer surplus or elasticities (Appendix J). The estimates used in this study are derived primarily from the following sources:

- Ministry of Natural Resources' (MNR) 1980 Survey of Ontario Resident and Non-Resident Sport Fishermen;
- MNR's 1980 Provincial Park Day and Camper Surveys;
- a 1984 Muskoka Second Home Study (a joint project of the District Municipality of Muskoka and the Muskoka Lakes Association);
- the 1982 Ontario Travel Survey; and
- "The Socio-economic Impact of the Walleye Sport Fishery on the Bay of Quite Region" by L.R.G. Martin of the University of Waterloo (October, 1985).

All expenditure estimates given in Exhibit 6.4 are expressed in 1985 dollars. Daily expenditures exclude capital investments i.e., purchases of consumer durables including boats, motors etc.

EXHIBIT 6.4: AVERAGE DAILY EXPENDITURES (1985 $ PER DAY)

	Activity		
Expenditures ($1985)	**Fishing**	**Swimming**	**Boating**
Local Residents	20	5	15
Other Residents			
Day User	35	15	25
Overnighter	60	30	50
Cottager	25	10	20
Non Ontario Residents	60	40	50

Source: DPA Group Inc. estimates based broadly on information in Table J.1

Daily expenditures for swimming are estimated to be much less than fishing or boating since specialized equipment is not required.

Although all expenditures are likely to occur in the province, only some portion of daily spending will actually occur in individual local regions. For example the 1980 Park survey cited above conlcudes that for the three parks studied, roughly one half of expenditures by day-users actually occurred in the local vicinity (i.e., within 40-50 km of the park).

Discussions with resort owners and local officials provide a relatively consistent estimate that about 75-80% of expenditures by overnighters are made in local region. Spending by cottagers which occurs in the local region is approximated at 70% of daily expenditures, based on a breakdown of spending by item (e.g., cottage repairs and renovations, groceries).

Assumptions regarding the percent of expenditures which occur within the local region are summarized below:

Purchases by	% in Local Region
Local Residents	100
Other Ontario Residents	
- Day-Users	50
- Overnighters	80
- Cottagers	70
Out-of-province Residents	80

The remaining expenditures are incurred in the rest of Ontario.

6.7 Economic Impact Multipliers

Income and employment multipliers for the three local regions are estimated in Appendix K based on a simple Keynesian (consumption) multiplier approach. Provincial multipliers are taken from the 1982 Ontario Ministry of Tourism and Recreation report -- **The Economic Impact of Tourism in Ontario and Regions, 1982.**

Estimates are presented in Exhibit 6.5 below.

EXHIBIT 6.5: ECONOMIC MULTIPLIERS

Region	Multiplier	
	Income	Employment PY's per $100,000 exp.
Rice Lake Area	0.70	2.78
West Lake Area	0.65	2.58
Muskoka/Haliburton Area	0.60	2.39
Province of Ontario	1.25	4.97

Source: Appendix K

For example, for the Rice Lake Area .70 times every dollar of visitor expenditure is estimated to represent income (value added) to the area.

The smaller regions have lower multipliers (than for the province) since a larger share of business and consumer purchases represents imports from out of the region. Detail on the multipliers is given in Appendix K.

FOOTNOTES

1. Based on movements in the Canada All Items CPI between 1981 and 1985.

2. See literature survey in Appendix J (Table J.2).

3. It has been suggested that "higher unit values may be assigned to those activities for which fewer alternatives are available and for which generally higher costs are incurred by participants". John F. Dwyer, John R. Kelly and Michael D. Bowes, "Improved Procedures for Valuation of the Contribution of Recreation to National Economic Development", University of Illinois at Urbana - Champaign Water Resources Centre Research Report No. 128, September 1977, p.22.

4. J.R. Miller and M.J. Hay, "Determinants of Hunter Participation: Duck Hunting in the Mississippi Flyway:, American Journal of Agricultural Economics, vol. 63, no. 4: 677-684, 1981.

5. In the actual calculations, the recreation use elasticity for boating is entered with a minus sign. The boating quality feature is the lack of aquatic plant growth -- the direct opposite of the level of aquatic plant growth. The -0.05 elasticity refers to the change in boating days with respect to a change in the level of aquatic plant growth.

7.0 THE CASE OF PHOSPHORUS CONTROL

In this Section the economic framework of Section 5.0 is illustrated in the context of a 25% reduction in phosphorus for each of the six lakes under study. The specific lake reclamation activity causing the phosphorus reduction is unspecified. It could include, however, restrictions on agricultural runoff or sewage effluent.

In the following analysis, it is assumed that the phosphorus reduction occurs instantaneously. The resulting changes in economic value and economic impacts represent annual changes or impacts in perpetuity.

Results are described in four parts:

- water quality and recreation quality impacts,
- impacts on recreation days,
- changes in recreation values, and
- economic impacts.

The results were calculated with the use of a simple spreadsheet model. Base case output results are presented in Appendix L.

As emphasized in the descriptions of the biophysical relationships (Section 4.4.2) and the underlying data and parameters (Section 6.0), the results should be viewed as illustrative due to the tentative nature of the information.

7.1 Water Quality and Recreation Quality Impacts

Changes in phosphorus levels in a lake will cause changes in water quality and associated recreation quality. A decrease in phosphorus will decrease the total biomass of fish in the lake, but will increase the proportion of that fish biomass comprising preferred species such as walleye, yellow perch, etc. A decrease in phosphorus will increase water clarity

and decrease aquatic weed growth, quality features of swimming and boating respectively.

A 25% decrease in phosphorus is projected to cause a decrease in the morphoedaphic index (MEI) of 57.5%, and this decrease in MEI will decrease the biomass of all fish species by 31.7%.[1] At the same time, the 25% decrease in phosphorus is projected to increase the share of preferred species by 100%.[2] Accordingly, catch of preferred species per unit effort (CPUE) -- the quality feature for sports fishing -- will increase by 36.6% (Exhibit 7.1).

Chlorophyll a concentrations act as a proxy for overall plant growth -- the main boating quality feature. Chlorophyll a concentrations decrease by 34.1% under a 25% reduction in phosphorus.[3]

A decrease in chlorophyll a concentration will increase Secchi disc readings, a measure of water clarity -- the quality feature for swimming. The 34.1% decrease in chlorophyll a causes an increase in Secchi disc readings that varies from lake to lake, ranging from a low of 8.7% increase (Mary Lake) to a high of 41.9% increase (Rice Lake).[4] The greatest relative changes in water clarity occur for lakes with low initial Secchi disc readings.

EXHIBIT 7.1: IMPACT OF 25% REDUCTION IN PHOSPHORUS ON BIOPHYSICAL PARAMETERS

	LAKE					
	West	Rice	Three Mile	Vernon	Mary	Fairy
	. . . % change . . .					
Lake Reclamation Activity						
Phosphorus Reduction	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0
Biophysical Impact						
Total Fish Biomass	-31.7	-31.7	-31.7	-31.7	-31.7	-31.7
Share Pref. Species	+100.0	+100.0	+100.0	+100.0	+100.0	+100.0
CPUE Pref. Species	+36.6	+36.6	+36.6	+36.6	+36.6	+36.6
Chlor a[a]	-34.1	-34.1	-34.1	-34.1	-34.1	-34.1
Secchi Disc[b]	+37.0	+41.9	+33.6	+9.5	+8.7	+13.0

[a] A proxy for weed density.
[b] A measure of water clarity.

7.2 Impacts on Recreation Days

The 25% increase in phosphorus results in an increase in fishing, boating and swimming quality. This quality improvement, in turn, results in an increase in these three recreation activities (Exhibit 7.2).

The decrease in phosphorus results in an additional 50,200 additional recreation days over all six lakes, ranging from a high of 34,100 days additional days for Rice lake to a 400 day increase for Fairy Lake. In relative terms, recreation days increase from 1-3% for each lake.

Lakes with higher proportions of fishing activity, as opposed to boating and swimming activities, experience the largest relative gains. This reflects the higher responsiveness of fishing activity to quality improvements[5], and the greater increase in fishing quality, as compared to boating and swimming activities, under phosphorus control.

7.3 Changes in Recreation Values

The 25% decrease in phosphorus results in an increase in fishing, boating, and swimming quality. This increase results in an increase in the satisfaction, enjoyment or value people receive from engaging in these activities (Exhibit 7.3).

Increases in economic (satisfaction) value are modest for the local regions uder study, ranging from $4,000 for Three Mile Lake to $47,000 for Rice Lake. This mainly reflects the fact that very little of the current recreation use of the lakes is by local residents. The majority is by other Ontario or out-of-province residents.

At the provincial level, increases in economic value due to phosphorus control are more substantial. Changes in value at

EXHIBIT 7.2: ANNUAL CHANGE IN RECREATION DAYS DUE TO 25% REDUCTION IN PHOSPHORUS

	Lake					
Activity/Residence	West	Rice	Three Mile	Vernon	Mary	Fairy
Fishing Total	1.5	22.4	0.9	0.4	0.2	-
Locals	0.1	1.3	0.1	0.1	-	-
Other Ontario Residents	1.2	13.9	0.8	0.3	0.2	-
Out-of-Province Residents	0.2	7.2	-	-	-	-
Boating Total	1.6	5.2	0.7	1.4	1.4	0.2
Locals	0.1	0.3	-	0.2	0.1	0.1
Other Ontario Residents	1.3	3.2	0.7	1.1	1.2	0.1
Out-of-Province Residents	0.2	1.7	-	0.1	0.1	-
Swimming Total	4.7	6.5	1.6	0.7	0.6	0.2
Locals	0.4	0.4	0.1	0.1	0.1	0.1
Other Ontario Residents	3.8	4.0	1.5	0.5	0.5	0.1
Out-of-Province Residents	0.5	2.1	-	0.1	-	-
All Activities	7.8	34.1	3.2	2.5	2.2	0.4
Locals	0.6	2.0	0.2	0.4	0.2	0.2
Other Ontario Residents	6.3	21.1	3.0	1.9	1.9	0.2
Out-of-Province Residents	0.9	11.0	-	0.2	0.1	-

EXHIBIT 7.3: ANNUAL CHANGE IN RECREATION VALUES[a] DUE TO 25% REDUCTION IN PHOSPHORUS

	Lake					
Residence/Activity	West	Rice	Three Mile	Vernon	Mary	Fairy
	. . . $000 . . .					
Local Residents Total	12	47	4	8	5	5
Fishing	3	33	1	2	-	1
Boating	4	9	1	5	4	3
Swimming	5	5	2	1	1	1
Provincial Residents Total[b]	266	1073	133	108	100	14
Fishing	62	742	44	19	10	2
Boating	85	205	40	72	74	9
Swimming	119	126	49	17	16	3

[a] economic (satisfaction) value accruing to recreationists
[b] includes local residents' value above

the provincial level represent changes in value by local residents plus changes in value by other Ontario residents. Ontario residents recreating at Rice Lake receive benefits in excess of $1 million due to phosphorus control. Provincial residents recreating at Fairy Lake receive a benefit of only $14,000.

Again lakes with a high proportion of fishing activity to total activity receive the largest relative increases. The relative increases in recreation value at the local or provincial level ranges from 3% (for Mary or Fairy Lakes) to 8% (for Rice Lake).

7.4 Economic Impacts

Changes in recreation quality result in income and employment impacts through the increase in cash expenditures by recreationists.

Incremental expenditures are those that would not have occurred without the lake reclamation project. For the local region, incremental expenditures are those associated with incremental recreation days by other Ontario and out-of-province residents. At the provincial level, incremental expenditures are those associated with incremental days by out-of-province residents.

Expenditures by residents internal to the region under study are not assumed to be incremental. Without the recreation opportunity on the lake, locals would have redirected their expenditures to other businesses in the region.

Incremental local expenditures by recreationists from a 25% reduction in phosphorus are $1.5 million in total for the local regions surrounding the six lakes (Exhibit 7.4). The bulk of this total occurs in the Rice Lake local area. Incremental expenditures in the Muskoka/Halburton area due to phosphorus control at Fairy Lake are minimal ($6,000).

EXHIBIT 7.4: ANNUAL ECONOMIC IMPACTS DUE TO 25% REDUCTION IN PHOSPHORUS

	Lake					
Residence/Activity	West	Rice	3 Mile	Vernon	Mary	Fairy
LOCAL REGION IMPACTS						
Inc. Expenditures ($000)	212	1104	53	61	62	6
Fishing	58	816	22	14	9	1
Boating	56	158	13	37	42	4
Swimming	98	130	18	10	11	1
Income Impacts ($000)[a,b]	138	773	32	37	37	4
Employment Impacts (PY's)[a]	6	31	1	1	1	-
PROVINCIAL IMPACTS						
Inc. Expenditures	40	600	1	8	8	2
Fishing	10	433	-	1	1	-
Boating	9	84	-	5	5	1
Swimming	21	83	1	2	2	1
Income Impacts ($000)[a,b]	49	750	1	11	10	3
Employment Impacts (PY's)[a]	2	30	-	-	-	-

[a] Impacts by activity follow the same distribution as incremental expenditures by activity
[b] value added

This $1.5 million in local expenditures result in $1.0 million in income (wages and salaries plus gross capital returns) and 40 person-years of employment to the six local regions. Over 70% of these economic impacts occur in the Rice Lake local area.

At the provincial level, economic impacts are only significant for Rice Lake ($750,000 income impact and 30 person-years employment impact). Impacts from phosphorus control at Rice Lake represents over 90% of total impacts across the six lakes. This occurs because Rice Lake has substantial visitation by out-of-province recreationists. The remaining five lakes have very little out-of-province visitation (Exhibit 3.2). At the provincial level, economic impacts only occur from incremental expenditures by out-of-province recreationists.

For all six lakes, incremental expenditures, income impacts and employment impacts are larger at the local level than at the provincial level.

7.5 Sensitivity Analysis

The foregoing results are sensitive to several key assumptions and/or parameters. Variations in the following are investigated:

- a 50% increase in economic value per recreation day for all activities,
- a 50% increase in average daily expenditures for all activities,
- a 50% increase in economic value and activity elasticities for all activities, and
- including expenditures by local residents in the impact calculations i.e., assuming that in the absence of the recreation opportunity local (provincial) residents would have diverted their expenditures outside the local (provincial) region.

Results for the total of all six lakes are reported in Exhibit 7.5.

A 50% increase in economic value per day results in a 50% increase in total economic value. Economic impacts do not change.

A 50% increase in average daily expenditures results in 50% increases in incremental expenditures, income impacts and employment impacts. Total economic value does not change.

A 50% increase in all value and activity elasticities results in slightly more than a 50% increase in total recreation (economic) value,[6] and results in a 50% increase in incremental expenditures and economic impacts.

Changing the definition of incremental expenditures to include expenditures by local residents has a significant impact on the calculations (Exhibit 7.5). At the provincial level, incremental expenditures change from $0.7 million to $2.0 million, and income impacts change from $0.8 million to $2.5 million. At the local region level, changes are more

EXHIBIT 7.5: SENSITIVITY ANALYSIS

ALL SIX LAKES	Base Case	Sensitivity Scenario: 50% Increase in Value/Day	50% Increase in Exp./Day	50% Increase in Elasticity Values	Include Local Expenditures in Impacts
INC. RECREATION DAYS ($000)	50	50	50	75	50
CHANGE IN RECREATION VALUE ($000)					
to Local Residents	81	122	81	123	81
to Provincial Residents	1694	2541	1694	2561	1694
ECONOMIC IMPACTS					
Local Region Impacts					
Inc. Expenditures ($000)	1498	1498	2247	2247	1548
Inc. Impacts ($000)	1021	1021	1531	1531	1053
Employment Impacts (PY's)	40	40	60	61	43
Provincial Impacts					
Inc. Expenditures ($000)	659	659	989	989	1960
Inc. Impacts ($000)	824	824	1236	1236	2451
Employment Impacts (PY's)	32	32	48	49	99

EXHIBIT 7.6: SUMMARY OF CHANGES IN RECREATION DAYS AND ECONOMIC VALUES AND OF ECONOMIC IMPACTS DUE TO A 25% REDUCTION IN PHOSPHORUS

	Lake						
	West	Rice	Three Mile	Vernon	Mary	Fairy	All
Incremental Recreation Days ('000)	7.8	34.1	3.2	2.5	2.2	0.4	50.2
Change in Recreation Values ($000)[a]							
to Local Residents	12	47	4	8	5	5	81
to Provincial Residents[c]	266	1073	133	108	100	14	1694
Economic Impacts							
Local Region Impacts							
Inc. Expenditures ($000)	212	1104	53	61	62	6	1498
Income Impacts ($000)[b]	138	773	32	37	37	4	1021
Employment Impacts (PY's)	6	31	1	1	1	-	40
Provincial Impacts							
Inc. Expenditures ($000)	40	600	1	8	8	2	659
Income Impacts ($000)[b]	49	750	1	11	10	3	824
Employment Impacts (PY's)	2	30	-	-	-	-	32

[a] economic (satisfaction) values
[b] value added
[c] includes local residents

modest. For example, incremental expenditures change from $1,498,000 to $1,548,000.

Accordingly, provincial impacts are greater than local region impacts under this alternate definition of incremental expenditures. The opposite holds true under the base case definition. Obviously, the economic impact calculations are highly sensitive to the definition of incremental expenditures employed.

7.6 Summary

A 25% decrease in phosphorus levels results in increased economic value and economic (income and employment) impacts for each of the six lakes under study. Benefits and impacts occur at the local and provincial level.

Over all six lakes, phosphorus reduction results in an increase in annual economic value of $81,000 to local residents and $1.7 million to provincial residents (Exhibit 7.6).

For the six lakes in total, the 25% reduction in phosphorus has an annual economic impact of $1.0 million of income or value-added and 40 person-years of employment. Economic impacts at the provincial level are $0.8 million income and 32 person-years employment.

Accordingly, economic impacts are larger at the local level than at the provincial level. The opposite relationship holds for economic values.

The largest increases in economic values and the largest economic impacts occur for Rice Lake. This reflects the current high level of recreation use, the significant use of Rice Lake by out-of-province visitors, and the fact that the largest proportion of recreation use is comprised of fishing. Recreation use and values for fishing are more sensitive to recreation quality than are boating or swimming.

Since effects are not felt evenly for each type of recreation use, lake reclamation activities such as phosphorus control have the potential to affect the mix of recreation on a particular lake.

This section has illustrated the application of the economic framework developed in Section 5.0. The underlying data and empirical relationships have been tentative in the sense that very little Ontario-specific information related to aquatic-based recreation exists. Results from other jurisdictions have been used.

Information and research needs are addressed in the concluding section of this report.

FOOTNOTES

1 Equations (1) and (2), Section 4.4.2
2 Equation (3), Section 4.4.2
3 Equation (5), Section 4.4.2
4 Equation (6), Section 4.4.2
5 That is, recreation use elasticities are higher for fishing (Section 6.4).
6 A change in consumer surplus can be represented as:

$$\Delta RS = \bar{R}\Delta S + \bar{S}\Delta R$$

Where

$\bar{R}$ = average of recreation days, before and after
$\bar{S}$ = average of consumer surplus per day, before and after
ΔR = change in recreation days
ΔS = change in average consumer surplus per day
ΔRS = Change in total consumer surplus per day

Accordingly, in the case at hand where the elasticities are much less than one, changing all value and activity elasticities by X% results in a change in total consumer surplus of only slightly more than X%.

8.0 FUTURE RESEARCH

In this study, an analytical framework was developed to estimate the change in aquatic-based recreation demand, value and economic activity resulting from the reclamation of environmentally impaired lakes. The framework was illustrated through application to six Ontario lakes under the reclamation scenario of 25% reduction in phosphorus.

The data and information to support the empirical work was drawn mainly from secondary sources -- information which largely related to fishing activity and which largely related to jurisdictions outside Ontario.

The use of secondary data and empirical results from outside the province is not desireable, but was necessary because of the dearth of recreation information on the six lakes studied. For example, U.S. lakes generally have higher phosphorus levels, do not support "cold water" fish species to the same extent, and have a different type and density of recreation use than do lakes in Ontario. These differences inhibit the application of U.S. results to Canada.

Two classes of information deficiencies represent major impediments to further work:

- the relationships or linkages between lake biophysical properties (e.g. phosphorus levels) and recreation quality factors (e.g., catch rates of preferred species) are imprecise, and
- no information exists as to the behaviour, motivatiions, expenditures, and substitute recreation activities of aquatic-based recreationists in Ontario.

These deficiencies should be addressed by the Ministry.

8.1 Lake Biophysical-Recreation Quality Relationships

Changes in recreation demand, value and activity flow from changes in recreation quality resulting from a specific lake reclamation activity. The empirical linkages between changes in lake biophysical properties and aquatic-based recreation quality are imprecise. Linkages are especially tentative for the fishing quality parameter -- catch rates of preferred species.

Time series and cross section data from a variety of Ontario lakes should be analyzed statistically to develop sounder empirical relationships between water quality and recreation quality parameters. This research effort would augment and enhance available research by Dillon and Rigler[1], Bay of Quinte project researchers[2], and others.

Bay of Quinte project results represent a rich information source on the impacts of phosphorus control on fish biomass by species group, and on weed and algae growth.

Research is needed not only in the area of phosphorus (eutrophication) control, but also is needed for assessing impacts of acidification and contamination control.

The outcome would be a firmer basis for projecting the impacts of a lake reclamation activity on recreation quality attributes.

8.2 Behaviour of Individual Recreationists

Very little is known concerning the behaviour of aquatic-based recreationists, and the role of water quality in recreation decisions in Ontario. Information gaps are especially acute with respect to boating and swimming recreation activity.

Analysis in this and other studies has relied mainly on secondary data, such as Ontario Travel Study data. Such aggregate data, however, are deficient in the following areas:

- the purpose of the trip is not necessarily recreation or leisure (also much of the data refer to multi-purpose and multi-destination trips),
- aquatic-based recreation cannot be segregated from other recreation/leisure activities,
- only total trip days and not recreation days are available,
- the trip and expenditure data are not site/lake specific,
- the data exclude recreation activity by local residents (i.e., those who do not travel), and
- one cannot determine the influence of lake water quality on recreation behaviour (since data does not refer to any specific lake and information was not collected on the role of water quality in recreation travel plans).

A need exists to collect lake specific recreation data to more accurately investigate the influence of water quality on recreation decisions, activities and values within Ontario.

Therefore, it is proposed that the Ministry conduct an on-site survey of aquatic-based recreationists for one or more lakes in the province. Recreationists would be queried as to:

- party characteristics (residence, number of people in the party),
- trip characteristics (main purpose, distance travelled, accommodation type, types of recreation activities),
- expenditure levels (durable and non-durable items by category),
- perceptions of water quality status,
- perceived change in recreation behaviour if water quality changed (including substitute lakes), and
- a contingnet valuation survey (willingness to pay and compensation required).

The data collected would allow one to derive recreation demand curves using both travel cost and contingent valuation techniques and using Ontario-specific data. It would also allow the investigation of the role of water quality on recreation decisions, values and activity, and thus aid MOE in assessing the benefits of specific lake rehabilitation initiatives.

The survey data would also act as benchmark data to support the conceptual framework developed in this study. Utilizing Ontario-specific survey data would represent a major improvement to the existing practice of using external data -- data collected for a different purpose and in a different context.

FOOTNOTES

1 P.J. Dillon and F.H. Rigler, "The Phosphorus-Chlorophyll Relationship in Lakes", Limnol. Oceanogr. 19:767-773, 1974. P.J. Dillon and F.H. Rigler, "A Simple Method for Predicting the Capacity of a Lake for Development Based on Lake Trophic Status", Journal of the Fisheries Research Board of Canada, 32:1519-1531, 1975.

2 C.K. Minns, D.A. Hurley and K.H. Nichols (Ed.), Project Quinte: Point-Source Phosphorus Control and Ecosystem Response in the Bay of Quinte, Lake Ontario, Canadian Special Publication of Fisheries and Aquatic Sciences 86, Ottawa, 1986.

APPENDIX A

METHODOLOGY FOR DETERMINING CURRENT RECREATION USE

APPENDIX A
METHODOLOGY FOR ESTIMATION OF CURRENT RECREATION USE

The number of aquatic-based recreation days was estimated for three types of facilities: commercial (e.g., resorts/ marinas), seasonal/permanent residences, and public facilities.

A.1 Commercial Facilities

Resorts were classified into: fixed roof (i.e., those providing rooms or cottages), trailer camps, and children's camps. Some facilities were marinas without any accommodation.

An inventory of facilities and their capacities was undertaken. Information was derived from the resort owner survey, accommodation guides, interviews with local officials, and inspection in the field. Seasonal and transient trailer facilities were segregated due to their vastly different use patterns.

A.1.1 Sample Estimates of Recreation Use

Recreation use by type (fixed roof, seasonal trailer, transient trailer, children's camp, and marina) was estimated for each resort or marina interviewed. Different procedures were used for each component.

Information on capacity rates, number of units in use, and number of people per unit were taken from the resort owner survey. The number of units was taken from the facility inventory.

Estimates were generated for each month (May through October) and summed. The methodology for estimating recreation use by type for each facility interviewed is outlined below.

Fixed Roof

Recreation days = # days in month x # units x capacity rate x # people per unit.

Seasonal Trailer Sites

Recreation days weekdays = # weekdays in month x average # sites in use on weekdays x # people per site

Recreation days weekends = #weekend days in month x average # sites in use on weekend days x # people per site

Recreation days = recreation days weekdays + recreation days weekends

Transient Trailer Sites

Recreation days = # days in month x # sites x capacity rate x # people per site

All Trailer Sites

Recreation days = Recreation Days Seasonal + Recreation Days Transient

Children's Camps

Recreation days = # days in month x # beds x capacity rate x 1

Marinas

Recreation days weekdays = # weekdays in month x # boats in use on weekdays x # people per boat

Recreation days weekends = #weekend days in month x # boats in use on weekend days x # people per boat

Boat counts exclude those associated with guest use or those belonging to lake area residents.

A.1.2 Population Estimates of Recreation Use

The estimates of recreation use based on facilities interviewed during the resort owner survey need to be extrapolated to the population of all commercial facilities around the lake.

Let r_{ij} = recreation days of type i at facility j (as estimated in Section A.1.1)
: i = 1,2,3,4 and j = 1,...,n

c_{ij} = capacity of type i at facility j
: i = 1,2,3,4 and j = 1,...,n

There are four types of facilities -- fixed roof, trailer sites, children's camps, and marinas. The sample size is n.

Summing over all facilities in the sample,

$r_i = \sum_j r_{ij}$
= recreation days of type i for all facilities in the sample

$c_i = \sum_j c_{ij}$
= resort capacity of type i for all facilities in the sample

From the facility inventory, we know

c_i = resort capacity of type i for all facilities in the population

Then, we estimate

$$R = \sum_i R_i$$

$$= \sum_i C_i \times r_i/c_i$$

where

R_i is the estimate of total recreation use of type i on the lake

R is the estimate of total recreation use (all types) on the lake

The above formulation is a ratio type estimater. For example, suppose that 3 of the 12 facilities offering fixed roof accommodation around the lake were interviewed. Suppose further that these 3 facilities encompassed 40 of the total 100 fixed roof rooms or cottages, and that the 3 facilities had 10,000 recreation days over the May through October season. Then, the estimate of total seasonal recreation days at all fixed roof accommodation on the lake would be 25,000 days (100 x 10,000/40).

A.2 Private Residences

Separate estimates were made for seasonal residents (cottages) and permanent residents.

For each type, seasonal (May through October) recreation use was estimated as:

No. units x days per season x no. people per unit.

The number of units came from the facility inventory. The other parameters were estimated as:

	Days/Season	No. People/Unit
Cottages	80	3.5
Permanent Residents	60	3.0

The days per season estimates for cottagers is based on

information in the "Lakeshore Capacity Study" (a weighted average of seasonal and extended summer use). Although permanent residents live year-round on the lake, they would not use the lake for recreation each day. It is estimated that they would use the lake primarily on weekends over the 20 week May through October period. A use rate of 60 days per season was adopted.

The estimates of number of people per residence are based on information from the "Lakeshore Capacity Study" and other secondary sources.

A.3 Public Facilities

The estimation of recreation use through public boat launches and beaches is difficult. Estimates derived for this study at each lake were based on the formulation:

days in the month x parking lot capacity x capacity rate x # people/car

Parking lot capacities were based on direct visual inspection or conversations with local officials. Values for capacity rate (including an allowance for turnover during the day) and number of people per car were judgements.

It should be emphasized that the estimates of recreation use associated with public facilities are less precise than the estimates of recreation use through commercial facilities and private residences. However, public facilities constitute only a small part of total recreation use on the lakes under study. Accordingly, any errors in estimating use rates for public facilities should not affect the estimates of total recreation days to any significant degree.

APPENDIX B

PROFILE OF WEST LAKE

TABLE B.1: BIOPHYSICAL INVENTORY OF WEST LAKE

Lake: West
Township:

Long/Lat: 76°54'/44°34'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	2036	Oct. 1971
2. Lake volume (cubic metres)	5229.0×10^5	Oct. 1971
3. Maximum depth (metres)	7.62	Oct. 1971
4. Mean depth (metres)	2.44	Oct. 1971
5. Total dissolved solids (milligrams/litre)	120	1985
6. Morphoedaphic index	49.2	1985
7. Secchi depth (metres)	0.8	1985
8. Phosphorus concentration (micrograms/litre)	52.0	1985
9. Chlorophyll-A concentrations (micrograms/litre)	11.2	1985
10. pH	7.9	1985

11. Presence of weeds/aquatic vegetation* (1971)

i) Myriophylliea	/ A	vi) Scirpus	/ B
ii) Chara	/ A	vii) Elodea	/ B
iii) Potomogeton Sp.	/ A	viii) Marsh Cress	/ C
iv) Vallisneria	/ A	ix) Zizania	/ C
v) Typha	/ B	x) Yellow Water Lily	/ C

12. Species of fish present/rank* (1971)

i) Yellow Pickerel	/	vi) Carp	/	xi) Rock Bass	/
ii) Smallmouth Bass	/	vii) Brown Bullhead	/	xii) Pumpkinseed	/
iii) Largemouth Bass	/	viii) Yellow Perch	/	xiii) Bluegill	/
iv) Northern Pike	/	ix) White Perch	/	xiv) Black Crappie	/
v) Longnose Gar	/	x) White Bass	/	xv) Golden Shiner	/

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

Source of Information:

. MNR Resource Map, Oct. 1971

TABLE 8.2: 1986 INVENTORY OF FACILITIES AT WEST LAKE

Inventory	Number of Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marinas
Resorts[a]	24	3	20	11	14	3
Fixed Roof[a]	12	2	12	1	2	1
Trailer/Campsites[a]	12	1	8	10	12	2
Children's Camp	-	. . . NA . . .				
Marinas[b]	1	-	-	-	-	1
Seasonal/Permanent Residences[c]	200	. . . NA . . .				
Public Facilities						
Launching Ramps	2	. . . NA . . .				
Beaches	1	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	3	36	22	6	12
Cottages	20	154	50	2	8
Subtotal	20	190			10
Trailer/Campsites					
Seasonal Trailers	11	580	225	3	53
Transient Trailers	14	804	411	2	57
Subtotal	14	1384			99
Camp Beds	-	-	-	-	-

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 80% seasonal/20% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE B.3: NUMBER OF RECREATION DAYS AT WEST LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	By Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
		(000s recreation days)			
Facility Type					
Fixed Roof	49.5				
Trailer/Campsites	192.1				
Children's Camps	---				
Marinas[a]	90.9				
Subtotal	332.5	20.0	269.3	23.3	20.0
Seasonal/Permanent Residences[b]	52.0	8.3	43.7	---	---
Public Facilities[c]	2.5	2.0	0.5	---	---
Total	387.0	30.3	313.4	23.3	20.0

[a] Includes day users at marinas associated with establishments providing accommodation.

[b] Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

[c] Estimates by the DPA Group Inc.

[d] Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of Days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	0.06	0.81	0.07	0.06	1.00
Seasonal/Permanent Residents	0.16	0.84	---	---	1.00
Public Facilities	0.80	0.20	---	---	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table C.1.

TABLE B.4: WATER QUALITY AND RECREATION USE ISSUES ON WEST LAKE

Resort operators expressed concerns over:

- . low catch rates for pickerel (walleye) and pike,
- . high levels of weeds,
- . large algae concentrations,
- . chemical pollution.

- The most serious problems are considered to be the weeds and the low catch rates for walleye. All operators felt these problems had become worse in recent years.
- The weed problem appears to affect both fishing and non-fishing recreation activities.
- In some areas of the lake, weeds make trolling and casting difficult, and it is hard to manoeuver the boat to properly address the fish. The weed problem seems to affect the less skilled fishermen more than the hardcore fishermen with specialized equipment (i.e., "bars boats").
- From 1981 to 1985, West Lake was particularly poor for walleye success rates.
- West Lake was known as a good walleye lake. It is no longer. (Fishing activity has dropped dramatically.)
- Angler success rates in 1986 were better than in the previous five years.
- For some small cottage operators with well-established repeat fishing clientele, the lack of fish has seriously reduced their bookings in the shoulder periods.
- These small part-time businesses do not advertise and are expected to suffer further loss of business. Once the habit-link to a particular resort is broken, it is hard to reestablish it.
- Operators suggested that the good walleye fishing in the Bay of Quinte has drawn away local day customers and West Lake resort customers.
- Many customers are complaining about sores on the walleye and pike. This further reduces the long term appeal of the lake to fishermen.
- Chemical pollution was mentioned by several operators as contributing to the weed problem.

... continued

TABLE B.4: continued

- The concerns centred on effluent from a commercial canning factory, sewage/septic field seepage from cottage developments, and agricultural runoff.

- The problems are compounded by the slow rate of natural flushing on the lake. West Lake is constricted in the middle, creating a north and south basin.

- The only entrance to Lake Ontario at the northern edge of the lake is a narrow 30 foot channel.

- The channel has become clogged with sand which further restricts water flow. (At certain times, you can walk over it.)

- There is a steady drift of sand coinciding with wind activity on Lake Ontario.

- In 1981, Ontario MNR and Canada DFO examined dredging options to improve conditions. It was concluded, however, that the problem was on-going and would require repeated, expensive dredging effort.

- The only proposed permanent solution involves initiating a long and deep breakwater on the Lake Ontario side to restrict sand build-up. The size of the required investment has stalled discussion of this action.

APPENDIX C

PROFILE OF RICE LAKE

TABLE C.1: BIOPHYSICAL INVENTORY OF RICE LAKE

Lake: Rice Lake
Township:

Long/Lat: 78° 10'/44° 12'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	10018.2	1972
2. Lake volume (cubic metres)	2.544×10^8	1972
3. Maximum depth (metres)	1.34	1972
4. Mean depth (metres)	2.55	1972
5. Total dissolved solids (milligrams/litre)	125	1972
6. Morphoedaphic index	49.0	
7. Secchi depth (metres)	1.6	1984
8. Phosphorus concentration (micrograms/litre)	41.3	1984
9. Chlorophyll-A concentrations (micrograms/litre)	19.1	1984
10. pH	8.3	1984

11. Presence of weeds/aquatic vegetation* (1972)

i) Wild Celery / A		vi) Sweet Gale / A	
ii) Pickerelweed / C		vii) Broadleadd Cattail / B	
iii) Pondweed / C		viii) Milfoil / A	
iv) White Water Lily / C		ix) Elodea / A	
v) Duckweed / C		x) Narrow leaf Cattail / B	

12. Species of fish present/rank* (1972)

i) Muskellunge /		vi) Largemouth Bass /		xi) Einscale Dase /	
ii) Common Carp /		vii) Yellow Perch /		xii) /	
iii) Rock Bass /		viii) Walleye /		xiii) /	
iv) Pumpkinseed /		ix) Brown Bullhead /		xiv) /	
v) Smallmouth Bass /		x) White Sucker /		xv) /	

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

Source of Information:

. MOE . Rice Lake Water Quality Data Only "Provisional Status of Data" available 1984, Stations R 33,34,35 and 36.
. MNR . Lake Survey Summary Sheet - August, 1972.

TABLE C.2: 1986 INVENTORY OF FACILITIES AT RICE LAKE

Inventory	Number of Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marinas
Resorts[a]	62	3	52	27	16	13
Fixed Roof[a]	38	3	37	4	2	7
Trailer/Campsites[a]	24	-	15	23	14	6
Children's Camp	-	. . . NA . . .				
Marinas[b]	5	-	-	-	-	5
Seasonal/Permanent Residences[c]	1382	. . . NA . . .				
Public Facilities						
Launching Ramps	7	. . . NA . . .				
Beaches	4	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	3	38	24	4	13
Cottages	52	605	57	2	12
Subtotal	53	643			12
Trailer/Campsites					
Seasonal Trailers	27	1361	285	1	50
Transient Trailers	16	349	113	2	22
Subtotal	28	1710			61
Camp Beds	-	-	-	-	-

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 90% seasonal/10% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE C.3: NUMBER OF RECREATION DAYS AT RICE LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	Days by Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
		(000's recreation days)			
Facility Type					
Fixed Roof	332.1				
Trailer/Campsites	411.5				
Children's Camps	---				
Marinas[a]	70.6				
Subtotal	814.2	16.3	407.1	---	390.8
Seasonal/Permanent Residences[b]	373.2	26.1	347.1	---	---
Public Facilities[c]	34.0	27.2	3.4	---	3.4
Total	1221.4	69.6	757.6	---	394.2

a Includes day users at marinas associated with establishments providing accommodation.

b Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

c Estimates by the DPA Group Inc.

d Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of Days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	0.02	0.50	---	0.48	1.00
Seasonal/Permanent Residents	0.07	0.93	---	---	1.00
Public Facilities	0.80	0.10	---	0.10	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table D.1.

TABLE C.4: WATER QUALITY AND RECREATION USE ISSUES ON RICE LAKE

Resort operators expressed concern about:

- . low catch rates of pickerel and muskie,
- . small size of pickerel,
- . high levels of weeds,
- . poor water clarity (algae problems),
- . foul odors,
- . fertilizer contamination,
- . chemical pollution,
- . user crowding.

- Weeds, algae, and size of pickerel were seen to be the most serious issues.

- Weeds have positive impact on fish habitat, but weeds are too thick in some sections of the lake.

- Some bad sections exist where boats have to make several passes through the weeds to clear a channel.

- The dense weeds deter some skilled fishermen.

- Two resort operators indicated that discussions at a recent sportsman's show suggested that Rice Lake was getting a reputation as too weedy.

- One operator suggested that the presence of high levels of weeds and poor water clarity (and algae) had the largest effect on non-fishing recreation activities, particularly swimming.

- Some operators felt that fishing activity was deteriorating. Others felt the catch rates were relatively stable over the past few years. A few operators felt that fishing activity had increased in their area of the lake, i.e., no real consensus existed.

- There seemed to be considerable concern over the size of pickerel being taken. The lack of a minimum size limit for pickerel is perceived to place added pressure on the species.

- The general consensus was that non-fishing activity at Rice Lake has increased.

- This is due in large part to larger promotional efforts and a general improvement in the facilities offered. (In contrast, these effects do not appear to have affected fishing activity levels.)

... continued

TABLE C.4: continued

- It is also perceived that if fishing quality decreases, the fishermen who have been coming to Rice Lake for years will not come back. This would seriously affect the fishing oriented properties.

- Chemical pollution is a general concern, especially as it affects the fitness of fish for eating, because of the potential impact on vacationers' choice of lakes.

- Operators reported that several fishing customers cancelled reservations because of a misinterpretation of a report on PCB levels in Rice Lake fish. Customers were told of the error, but several bookings were lost.

- The PCBs reported in Little Lake within Peterborough and the unknown composition of the Peterborough sewage effluent which finds its way into Rice Lake also were pollution concerns.

- Large commercial farms have runoff of fertilizer and other chemicals into the lake. This spurs weed and algae growth.

- Some operators reported concern over ill-trained houseboat operators who come through Rice Lake on vacation. Most rent the boats and some apparently have little knowledge of how to operate them (evidenced by damaged docks and regular discharges of grey water).

- A submerged railway track at one location on the lake creates a potential boating hazard.

Source: Resort Operator Survey responses.

APPENDIX D

PROFILE OF THREE MILE LAKE

TABLE D.1: BIOPHYSICAL INVENTORY OF THREE MILE LAKE

Lake: Three Mile
Township:

Long/Lat: 79°27'/45°10'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	929.2	1972
2. Lake volume (cubic metres)	322.3×10^5	1972
3. Maximum depth (metres)	11	1972
4. Mean depth (metres)	3.5	1972
5. Total dissolved solids (milligrams/litre)	29.4	1972
6. Morphoedaphic index	8.0	
7. Secchi depth (metres)	1.3[a]	1984
8. Phosphorus concentration (micrograms/litre)	18	1975
9. Chlorophyll-A concentrations (micrograms/litre)	8.3b	1984
10. pH	6.7	1975

11. Presence of weeds/aquatic vegetation* (1972)

i) Sweet Gale / A		vi) _____ / _____	
ii) Curly Pondweed / A		vii) _____ / _____	
iii) Pickerel Weed / B		viii) _____ / _____	
iv) Watershield / B		ix) _____ / _____	
v) Cattail / B		x) _____ / _____	

12. Species of fish present/rank* (1972)

i) Pickerel / _____	vi) Brown Bullhead / _____	xi) _____ / _____
ii) Smallmouth Bass / _____	vii) Ciscoe / _____	xii) _____ / _____
iii) Creek Chub / _____	viii) _____ / _____	xiii) _____ / _____
iv) Yellow Perch / _____	ix) _____ / _____	xiv) _____ / _____
v) Pumpkinseed / _____	x) _____ / _____	xv) _____ / _____

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

[a] Value refers to main basin, Hammel Bay value is 3.6
[b] Value refers to main basin, Hammel Bay value is 3.8.

Source of Information:

. MOE - Secchi Disck - Chlorophyll-A - Self Help Program Report - Wattward, District Municipality of Muskoka - 1984
. MOE - MNR Lake Sampling Program - Data Sheets - May 1975.
. MNR - Lake Summary Sheet - January 1972.

TABLE D.2: 1986 INVENTORY OF FACILITIES AT THREE MILE LAKE

Inventory	Number of Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marinas
Resorts[a]	6	-	5	3	2	-
Fixed Roof[a]	4	-	4	1	-	-
Trailer/Campsites[a]	2	-	1	2	2	-
Children's Camp	-	. . . NA . . .				
Marinas[b]	-	-	-	-	-	-
Seasonal/Permanent Residences[c]	457	. . . NA . . .				
Public Facilities						
Launching Ramps	1	. . . NA . . .				
Benches	-	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	-	-	-	-	-
Cottages	5	59	20	4	12
Subtotal	5	59	20	4	12
Trailer/Campsites					
Seasonal Trailers	3	30	15	6	10
Transient Trailers	2	67	36	31	33
Subtotal	3	97			32
Camp Beds	-	-	-	-	-

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 90% seasonal/10% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE D.3: NUMBER OF RECREATION DAYS AT THREE MILE LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	By Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
		(000s recreation days)			
Facility Type					
Fixed Roof	18.8				
Trailer/Campsites	20.1				
Children's Camps	---				
Marinas[a]	0.2				
Subtotal	39.1	---	37.9	0.4	0.8
Seasonal/Permanent Residences[b]	123.4	8.6	114.8	---	---
Public Facilities[c]	0.5	0.4	0.1	---	---
Total	163.0	9.0	152.8	0.4	0.8

[a] Includes day users at marinas associated with establishments providing accommodation.

[b] Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

[c] Estimates by the DPA Group Inc.

[d] Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of Days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	---	0.97	0.01	0.02	1.00
Seasonal/Permanent Residents	0.07	0.93	---	---	1.00
Public Facilities	0.80	0.20	---	---	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table E.1.

TABLE D.4: WATER QUALITY AND RECREATION USE ISSUES ON THREE MILE LAKE

Resort operators expressed concern over:
- . low catch rates and size of walleye,
- . worms in fish,
- . weed problems.

- The main water quality problems are fishing-related and weed-related.
- Three Mile had a reputation as a good fishing lake, but fishing quality has decreased.
- Operators suggested the introduction of pike to the lake may thin out the population of rock bass and may reduce the incidence of worm problems.
- The worms and low walleye success rates have caused at least one operator to lose long standing repeat customers.
- The current practice of using walleye eggs from spawning Three Mile Lake fish to stock other lakes is perceived as a contributing factor to the low walleye population.
- Weeds are also considered to be a problem, and they are getting worse. This has a negative impact on both the fishing and swimming vacation experiences.

APPENDIX E

PROFILE OF VERNON LAKE

TABLE E.1: BIOPHYSICAL INVENTORY OF VERNON LAKE

Lake: Vernon
Township: _____

Long/Lat: 79° 17'/45° 20'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	1443	1973
2. Lake volume (cubic metres)	1828.8×10^5	1983
3. Maximum depth (metres)	38	1985
4. Mean depth (metres)	12.7	1983
5. Total dissolved solids (milligrams/litre)	24.0	1983
6. Morphoedaphic index	1.9	
7. Secchi depth (metres)	2.25	1985
8. Phosphorus concentration (micrograms/litre)	11	1985
9. Chlorophyll-A concentrations (micrograms/litre)	1.0[a]	1985
10. pH	6.0	1975

11. Presence of weeds/aquatic vegetation* (1969)

i) Pickerel Weed / A		vi) _____ / _____	
ii) Rushes / A		vii) _____ / _____	
iii) Yellow Water Lily / B		viii) _____ / _____	
iv) White Water Lily / B		ix) _____ / _____	
v) Water Obelia / B		x) _____ / _____	

12. Species of fish present/rank* (1969)

i) Lake Trout / _____	vi) Brown Bullhead / _____	xi) Blunt Nose Min. / _____
ii) Smallmouth Bass / _____	vii) Lake Whitefish / _____	xii) Common Shiner / _____
iii) Largemouth Bass / _____	viii) Rainbow Smelt / _____	xiii) Creek Chub / _____
iv) Long Nose Sucker / _____	ix) Pumpkinseed / _____	xiv) _____ / _____
v) White Sucker / _____	x) Yellow Perch / _____	xv) _____ / _____

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

[a] Corrected value 1.7.

Source of Information:

- MNR 1985 Computer Database.
- Cottage carrying capacities for 44 lakes in the District Municipality of Muskoka, Vol. 1, March 1983.
- MNR Lake Survey Summary - Aquatic Habitat Inventory - Chemistry Update, August, 1975.
- MNR Lake Survey Summary Sheet, August 1973.
- MNR Lake Survey Summary Sheet, June 1969.

TABLE E.2: 1986 INVENTORY OF FACILITIES AT VERNON LAKE

Inventory	Number of Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marinas
Resorts[a]	7	2	3	2	2	1
Fixed Roof[a]	3	1	3	-	-	1
Trailer/Campsites[a]	2	1	-	2	2	-
Children's Camp	2	. . . NA . . .				
Marinas[b]	1	-	-	-	-	1
Seasonal/Permanent Residences[c]	272	. . . NA . . .				
Public Facilities						
Launching Ramps	2	. . . NA . . .				
Beaches	1	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	2	6	3	3	3
Cottages	3	17	8	4	6
Subtotal	4	23			6
Trailer/Campsites					
Seasonal Trailers	2	91	65	26	46
Transient Trailers	2	82	67	15	41
Subtotal	2	173			87
Camp Beds	2	541	391	150	271

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 87% seasonal/13% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE E.3: NUMBER OF RECREATION DAYS AT VERNON LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	By Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
		(000s recreation days)			
Facility Type					
Fixed Roof	12.9				
Trailer/Campsites	47.5				
Children's Camps	68.7				
Marinas[a]	6.6				
Subtotal	135.7	5.4	114.0	8.1	8.1
Seasonal/Permanent Residences[b]	72.8	6.6	66.2	---	---
Public Facilities[c]	21.0	16.8	4.2	---	---
Total	229.5	28.8	184.5	8.1	8.1

[a] Includes day users at marinas associated with establishments providing accommodation.

[b] Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

[c] Estimates by the DPA Group Inc.

[d] Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	0.04	0.84	0.06	0.06	1.00
Seasonal/Permanent Residents	0.09	0.91	---	---	1.00
Public Facilities	0.80	0.20	---	---	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table F.1.

TABLE E.4: WATER QUALITY AND RECREATION USE ISSUES ON LAKE VERNON

Water quality issues are not a major concern of resort operators on Lake Vernon. Issues mentioned were:

- . low catch rates of trout and bass,
- . water clarity,
- . acid rain (affecting trees, not the water).

- There was a consensus that water quality was important since it is the main attraction. There was no consensus on whether problems were getting better or worse.

- Operators were not aware of mercurcy contamination of fish.

- One operator at the outlet to the Big East River expressed concerns over factory pollution, complaints of wormy trout, and high spring runoff levels which enhance flooding potential. (These are localized perceptions/issues, not applicable to the whole lake.)

- In summary, there are few perceptions of water quality issues.

APPENDIX F

PROFILE OF MARY LAKE

TABLE F.1: BIOPHYSICAL INVENTORY OF MARY LAKE

Lake: Mary Lake
Township: _____

Long/Lat: 79° 15'/45° 15'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	1061	1981
2. Lake volume (cubic metres)	2625.4×10^3	1981
3. Maximum depth (metres)	55	1985
4. Mean depth (metres)	24.7	1981
5. Total dissolved solids (milligrams/litre)	26.6	1981
6. Morphoedaphic index	1.1	
7. Secchi depth (metres)	2.8	1985
8. Phosphorus concentration (micrograms/litre)	7	1985
9. Chlorophyll-A concentrations (micrograms/litre)	0.9[a]	1985
10. pH	6.3	1975
11. Presence of weeds/aquatic vegetation* (1970)		

i) Sweet Gale / B
ii) White Water Lily / C
iii) Yellow Water Lily / C
iv) Pickerel Weed / C
v) Pondweed / C
vi) Northern Pipewort / C
vii) _____ / _____
viii) _____ / _____
ix) _____ / _____
x) _____ / _____

12. Species of fish present/rank* (1970)

i) Lake Trout / _____
ii) Brook Trout / _____
iii) Smallmouth Bass / _____
iv) Rainbow Trout / _____
v) White Sucker / _____
vi) Longnose Sucker / _____
vii) Yellow Perch / _____
viii) Cisco / _____
ix) Lake Whitefish / _____
x) Burbot / _____
xi) Brown Bullhead / _____
xii) Rainbow Smelt / _____
xiii) Pumpkinseed / _____
xiv) _____ / _____
xv) _____ / _____

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

[a] Corrected value 1.4.

Source of Information:

- MNR 1985 Computer Database.
- Cottage carrying capacity for 44 lakes in the District Municipality of Muskoka, Vol. 1, March 1983.
- MNR Lake Survey Summary - Aquatic Habitat Inventory - Chemistry Update, August 1975.
- MNR Lake Survey Summary Sheet - June 1970.

TABLE F.2: 1986 INVENTORY OF FACILITIES AT MARY LAKE

Inventory	Number of Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marinas
Resorts[a]	9	3	6	1	1	1
Fixed Roof[a]	5	3	5	-	-	-
Trailer/Campsites[a]	1	-	1	1	1	1
Children's Camp	3	. . . NA . . .				
Marinas[b]	1	-	-	-	-	1
Seasonal/Permanent Residences[c]	200	. . . NA . . .				
Public Facilities						
Launching Ramps	2	. . . NA . . .				
Beaches	3	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	3	42	16	11	14
Cottages	6	155	137	1	26
Subtotal	6	197			33
Trailer/Campsites					
Seasonal Trailers	1	250	250	250	250
Transient Trailers	1	30	30	30	30
Subtotal	1	280			280
Camp Beds	3	486	256	50	162

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 80% seasonal/20% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE F.3: NUMBER OF RECREATION DAYS AT MARY LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	By Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
	- - -	(000s recreation days)	- - -		
Facility Type					
Fixed Roof	66.1				
Trailer/Campsites	35.5				
Children's Camps	50.2				
Marinas[a]	1.6				
Subtotal	153.4	1.5	135.0	7.7	9.2
Seasonal/Permanent Residences[b]	52.0	7.3	44.7	---	---
Public Facilities[c]	15.0	12.0	3.0	---	---
Total	220.4	20.8	182.7	7.7	9.2

[a] Includes day users at marinas associated with establishments providing accommodation.

[b] Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

[c] Estimates by the DPA Group Inc.

[d] Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of Days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	0.01	0.88	0.05	0.06	1.00
Seasonal/Permanent Residents	0.14	0.86	---	---	1.00
Public Facilities	0.80	0.20	---	---	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table G.1.

TABLE F.4: WATER QUALITY AND RECREATION USE ISSUES ON MARY LAKE

Water quality issues are not a major concern on Mary Lake. Issues mentioned were:

- . low catch rate of bass and trout,
- . small size of bass and trout,
- . acid rain (affecting trees, not fish).

- The resorts do not focus on fishing so that the low catch rates are not considered a deterent to lake use.
- The lake is stocked annually, i.e., trout cannot reproduce naturally.
- Trout angling success is better in winter than in summer.
- The acid rain concern reflects its impact on the foliage (i.e., maple trees) surrounding the lake.
- The restricted hours for the locks connecting Mary to the Vernon system restricts boating traffic in Mary Lake.
- One operator expressed concern over effluent from the Huntsville sewage treatment plant which finds its way into Mary Lake.
- The brown water colour reflects the particular substrate underlying the lake, and is not an indicator of pollution.
- Operators were not aware of any mercury problems in the lake.

APPENDIX G

PROFILE OF FAIRY LAKE

TABLE G.1: BIOPHYSICAL INVENTORY OF FAIRY LAKE

Lake: Fairy Lake
Township: _____

Long/Lat: 79° 11'/45° 20'

BIOPHYSICAL INVENTORY

		Date of Information
1. Lake area (hectares)	732	1983
2. Lake volume (cubic metres)	1565.9×10^6	1969
3. Maximum depth (metres)	55	1985
4. Mean depth (metres)	22.1	1969
5. Total dissolved solids (milligrams/litre)	22.8	1969
6. Morphoedaphic index	1.0	
7. Secchi depth (metres)	2.7	1985
8. Phosphorus concentration (micrograms/litre)	8	1985
9. Chlorophyll-A concentrations (micrograms/litre)	1.5[a]	1985
10. pH	6.4	1975

11. Presence of weeds/aquatic vegetation

i)	Pickerel Weed / B	vi)	_____ / _____
ii)	Cattails / C	vii)	_____ / _____
iii)	Quillwart / C	viii)	_____ / _____
iv)	White Water Lily / C	ix)	_____ / _____
v)	Yellow Water Lily / B	x)	_____ / _____

12. Species of fish present/rank*

i)	Lake Trout / _____	vi)	Cisco / _____	xi)	_____ / _____
ii)	Smallmouth Bass / _____	vii)	Rainbow Smelt / _____	xii)	_____ / _____
iii)	Lake Whitefish / _____	viii)	_____ / _____	xiii)	_____ / _____
iv)	White Sucker / _____	ix)	_____ / _____	xiv)	_____ / _____
v)	Yellow Perch / _____	x)	_____ / _____	xv)	_____ / _____

* Rank
(A) Abundant
(B) Common
(C) Occasional
(D) Rare

[a] Corrected value is 2.1.

Source of Information:

- MNR 1985 Computer Database.
- Cottage carrying capacities for 44 lakes in the District Municipality of Muskoka, Vol. 1, March 1983.
- MNR Lake Survey Summary - Aquatic Habitat Inventory - Chemistry Update - July 1975.
- MNR Lake Survey Summary Sheet - July 1969.

TABLE G.2: 1986 INVENTORY OF FACILITIES AT FAIRY LAKE

Inventory	Number Facilities	Number Providing				
		Rooms	Cottages	Seasonal Trailers	Transient Trailers	Marina's
Resorts[a]	2	1	1	-	-	-
Fixed Roof[a]	1	1	1	-	-	-
Trailer/Campsites[a]	-	-	-	-	-	-
Children's Camp	1	. . . NA . . .				
Marinas[b]	1	-	-	-	-	1
Seasonal/Permanent Residences[c]	107	. . . NA . . .				
Public Facilities						
Launching Ramps	1	. . . NA . . .				
Beaches	1	. . . NA . . .				

Resort Capacity	Number Providing	Capacity			
		Total	Max	Min	Average
Fixed Roof					
Rooms	1	8	8	8	8
Cottages	1	5	5	5	5
Subtotal	1	13	13	13	13
Trailer/Campsites					
Seasonal Trailers	-	-	-	-	-
Transient Trailers	-	-	-	-	-
Subtotal	-	-	-	-	-
Camp Beds	1	120	120	120	120

[a] Excludes marinas without accommodation facilities.

[b] Excludes marinas with accommodation facilities.

[c] 20% seasonal/ 80% permanent.

Source: Derived from resort owner survey, accommodation guides and information from local officials.

TABLE G.3: NUMBER OF RECREATION DAYS AT FAIRY LAKE BY FACILITY TYPE AND RESIDENCE CLASS

	Total	By Resident Class[d]			
		Locals	Ont.	Rest of Can.	Other
	(000s recreation days)				
Facility Type					
Fixed Roof	3.2				
Trailer/Campsites	---				
Children's Camps	6.3				
Marinas[a]	4.7				
Subtotal	14.2	1.0	9.2	0.9	3.1
Seasonal/Permanent Residences[b]	12.4	15.4	6.0	---	---
Public Facilities[c]	2.5	2.0	0.5	---	---
Total	38.1	18.4	15.7	0.9	3.1

[a] Includes day users at marinas associated with establishments providing accommodation.

[b] Assumed 80 days use (May - Oct) and 3.5 people per household for seasonal residents -- i.e., cottagers; assumed 60 days use (May - Oct) and 3.0 people per household for permanent residents.

[c] Estimates by the DPA Group Inc.

[d] Based on the following distribution of recreation days derived from the resort and local official surveys, and secondary information.

	Fraction of Days by Residence Class				
	Locals	Ont.	Rest of Can.	Other	All
Resorts/Marinas	0.07	0.65	0.06	0.22	1.00
Seasonal/Permanent Residents	0.72	0.28	---	---	1.00
Public Facilities	0.80	0.20	---	---	1.00

Source: Derived from resort and local official survey data and the facility inventory of Table H.1.

TABLE G.4: WATER QUALITY AND RECREATION USE ISSUES ON FAIRY LAKE

Water quality issues are not a major concern in Fairy Lake. The following issues are not considered serious:

- . fitness of fish for eating (bass),
- . acid rain,
- . chemical pollution.

- The above problems were perceived to be getting worse.
- Fishing is not a major activity, but the incidence of worms in the bass was considered a deterent to fishing activity.
- The acid rain issue is a high profile one because the local MP has taken an active interest in it. The issue refers to the impact of acid rain on foliage and not on water quality.
- The reference to chemical pollution reflects concerns over the sewage from Huntsville and from cottage/residence septic systems.

APPENDIX H

SURVEY INSTRUMENTS

QUESTIONNAIRE

For information contact:
The DPA Group Inc.
903 - 347 Bay Street
Toronto, Ontario
M5H 2R7
Phone: (416) 368-1711
Attention: Brian McGowan or
Sophia Lukovich

Office Use Only
Lake _____
Resort Number _____

ONTARIO MINISTRY OF THE ENVIRONMENT
CONFIDENTIAL RECREATION AND WATER QUALITY SURVEY

RESORT AND MARINA COMPONENT

This survey/interview concerns present recreation use and water quality issues on Lake _____. We are interested in your views of the role of water quality in recreation.

Please respond to the following questions to the best of your ability (estimate reasonable values if precise data are not available).

TYPE OF BUSINESS

The following is a list of broad industry catagories, please check the one which most appropriately describes your business.

Large Hotel	____	Housekeeping Resort	____
Small Hotel	____	Fishing/Hunting Lodge	____
Motor Hotel	____	Fishing/Hunting Camp	____
Motel	____	Marina	____
Resort Hotel	____	Other: (Specify)	____
Resort Lodge	____	_____	

Name of Business: _____
Street: _____
City/Town: _____

Name of Respondent: _____
Position: _____
Date Completed: _____

A) YOUR FACILITY

1. What months of the year is the facility open?

_____ through _____

2. What recreation facilities does your resort provide?

	Check if Yes
General Boating	
Marina	____
Boat launch ramp	____
Boat/canoe rentals	____
Windsurfer rentals	____
Services & supplies (e.g. gas)	____
Other: (Specify)	
_____	
_____	
Fishing	
Pier for fishing	____
Guides	____
Bait	____
Fishing Supplies	____
Other: (Specify)	
_____	
_____	
Swimming	
Bath/change house	____
Raft or float	____
Diving board	____
Enclosed swimming area	____
Lifeguards	____
Other: (Specify)	
_____	
_____	
Other	
Sand beach	____
Playground	____
Walking trails	____
Picnic tables	____
Fireplaces/grills	____
Game areas (tennis, baseball, etc)	____
Restaurant	____
Concession stand	____
Food store	____
Gas station	____
Other: (Specify)	
_____	
_____	

3. What accommodation facilities does your resort provide?

None _____ ----------> Go to Section C

OR

	Check if Yes	Capacity
Room accommodation (or cottages)	_____	_____ units
Seasonal trailer sites	_____	_____ sites
Transient campsites/trailer sites	_____	_____ sites
Other: (Specify)		
_____	_____	_____

Which type of facility do most of your guests use? _____

On a peak summer weekend day, how busy are your facilities?

Room accommodation	_____% of capacity
Seasonal trailer sites	_____% of capacity
Transient campsites/trailer sites	_____% of capacity
Other: (Specify)	
_____	_____% of capacity

B) RECREATION ACTIVITY AT YOUR FACILITY (For Resorts Only)

The recreation users at your facility can be divided into day users and accommodation users (i.e. users of rooms, campsites, trailer sites).

4. What are the three most frequent recreation activities of your guests? (Mark 1 - most frequent, 2 - second most frequent, 3 - third most frequent beside those listed below.)

	Guests Using Accommodation	Day Users
Swimming	_____	_____
Fishing	_____	_____
Boating (includes canoeing, sailing waterskiing, windsurfing)	_____	_____
Hiking/walking	_____	_____
Picnicing	_____	_____
Bicycling	_____	_____
Games (tennis, baseball, etc)	_____	_____
General relaxation	_____	_____
Other: (Specify)		
_____	_____	_____

5. Recreation activity can be described as follows:

a) On a peak summer weekend day, the approximate number of people using your facility are:

_____ day users
_____ guests using accommodation
_____ total

b) Over the whole season, the percentage of recreation users at your facility is:

_____ % day users
_____ % guests using accommodation
100 % total

6. On average, how many people stay in one unit of each type of facility?

_____ room accommodation (cottage)
_____ seasonal trailer site
_____ transient trailer site/campsite

7. Approximately what is your summer occupancy on a monthly basis:

	May	June	July	Aug	Sept	Oct
Room accommodation (cottages)	___%	___%	___%	___%	___%	___%
Transient trailer sites/ campsites	___%	___%	___%	___%	___%	___%

For seasonal trailer sites, how many are used:

	May	June	July	Aug	Sept	Oct
a) on most weekend days	___	___	___	___	___	___
b) on most weekdays	___	___	___	___	___	___

8. Approximately what share of groups using your main type of accommodation stay:

1 night	_____%
2 nights	_____%
3-6 nights	_____%
7 or more nights	_____%
Total	100%

9. Approximately what share of groups using your accommodation facilities live:

	Room Guests	Transient trailer Site/ Campsite Guests
In the local area	_____%	_____%
In the rest of Ontario	_____%	_____%
In other provinces	_____%	_____%
In other countries	_____%	_____%
Total	100%	100%

10. Approximately what percentage of your business revenue comes from:

Accommodation (include campsites, etc)	____%
Food & Beverage	____%
Boating/fishing related rentals	____%
Boating/fishing supplies	____%
Other: (Specify)	____%
_____	
	100%

Approximately what percentage of your revenue comes from:

Guests using accommodation	____%
Day users	____%
Other	____%
	100%

C) RECREATION ACTIVITY AT YOUR BOATING FACILITY

For the purpose of this research the term "marina" has been broadened to include any facility which offers to the public:

- boat rentals
- boat launch ramps
- gas and oil

If you do not offer a "marina" facility, GO TO SECTION D

11. We are trying to get a sense of the number of boaters originating from your facility each month.

a) On a typical weekend day the activity can be described as:

	MAY	JUNE	JULY	AUG	SEPT	OCT
Number of rental boats in use	___	___	___	___	___	___
Number of boats in use which are associated with seasonal trailer sites	___	___	___	___	___	___
Number of guest's boats in use	___	___	___	___	___	___
Number of day users launching boats	___	___	___	___	___	___

b) On a typical weekday the activity can be described as:

	MAY	JUNE	JULY	AUG	SEPT	OCT
Number of rental boats in use	____	____	____	____	____	____
Number of boats in use which are associated with seasonal trailor sites	____	____	____	____	____	____
Number of guest's boats in use	____	____	____	____	____	____
Number of day users launching boats	____	____	____	____	____	____

12. What is the average number of people in the boating groups using your facility?

_____ people per boat.

If your facility offers accommodation GO TO SECTION D.
Otherwise proceed with questions 13 and 14.

13. What are the three most frequent recreation activities of your facility users? (Mark 1 - most frequent, 2 - second most frequent, 3 - third most frequent beside those activities listed below.)

Swimming	_____
Fishing	_____
Boating (include canoeing, sailing, waterskiing, windsurfing)	_____
Hiking/walking	_____
Picnicing	_____
Bicycling	_____
Games (tennis, baseball, etc)	_____
General relaxation	_____
Other: (Specify)	_____

_____

14. Approximately what percentage of your receipts are from:

Boating/fishing related rentals, moorage, etc	_____%
Food & Beverage	_____%
Boating/fishing supplies	_____%
Other: (Specify)	_____%
Total	100%

D) RECREATION ACTIVITY ON THE WHOLE LAKE (If your business offers both accommodation and marina facilities, answer both parts of each question.)

15. How many resorts or marinas are located along this lake?

_____ resorts _____ marinas

16. We are trying to estimate the total number of lake users that stay at resorts along the lake, but we are only talking to a sample of resort operators.

What percent of the total do you think stay at your resort? _____%

For marinas: We are estimating the total number of boating groups who use marinas or launch ramps along this lake. What percent of the total do you think use your facility? _____%

17. Based on your experience in the area, indicate the split of summer recreation users (boating groups) on the whole lake among the following categories:

		for marinas:	
Resort guests	_____%	Resort users	_____%
Cottagers	_____%	Cottagers	_____%
Day users and others	_____%	Day users and others	_____%
Total	100%	Total	100%

E) SUBSTITUTE LAKES

18. Are there lakes close by that offer the same species and quality for sportfishing?

No _____ ========> How far away is the nearest comparable fishing quality lake? _____ miles (km)
Go to Question 19

Yes _____ ========> Which ones? (maximum of 3)
Lake #1: _____
Lake #2: _____
Lake #3: _____

19. Are there lakes close by that act as substitutes or competitors for non-fishing recreation activity on this lake?

No _____ ------> How far away is the nearest comparable lake?
_____ miles (km)
Go to Question 20

Yes _____ ------> Which ones? (maximum of 3)
Lake #1: _____
Lake #2: _____
Lake #3: _____

20. Has sport fishing activity on this lake increased, decreased or remained the same over the past 20 years (or as long as you have been associated with the lake)?

(check one)

Do not know _____
Remained the same _____
Decreased _____
Increased _____ } Why? _____

21. Has non-fishing recreation activity increased, decreased or remained the same over the past 20 years (or as long as you have been associated with the lake)?

(check one)

Do not know _____
Remained the same _____
Decreased _____
Increased _____ } Why? _____

F) WATER QUALITY ISSUES ON THIS LAKE

22. Which of the following do you see as a problem(s) on this lake in general (and not just at your resort)? Classify as: major problem, minor problem, or no problem.

	Major Problem	Minor Problem	No Problem
Lack of desireable fish species	____	____	____
If a problem, specify species _____			
Low catch rates of desireable species	____	____	____
If a problem, specify species _____			
Small size of fish	____	____	____
If a problem, specify species _____			
Fitness of fish for eating	____	____	____
If a problem, specify species _____			
Crowding of boats in water	____	____	____
Crowding of swimmers/beach users	____	____	____
Water clarity	____	____	____
Presence of weeds/aquatic plants	____	____	____
Presence of algae scums/accumulations	____	____	____
Bacterial contamination	____	____	____
Acid rain	____	____	____
Oil, grease, scum or floating debris	____	____	____
Fitness of water for drinking	____	____	____
Foul odours from the lake	____	____	____
Chemical pollution: (Specify)	____	____	____
_____			
Other: (Specify)			
_____			
_____	____	____	____

23. What do you consider the three most serious problems of those noted above?

Most serious problem _____

_____

Second most serious problem _____

_____

Third most serious problem _____

_____

24. During the time which you have been associated with this lake, has there been a change in any of these problem areas?

NO _____ Go to Question 25

YES _____ Indicate below, the direction of the change and the time period over which you have noticed the change.

	Became Worse	Became Better	Remained Same	Do Not Know	Time Period (in years)
Most serious problem	_____	_____	_____	_____	_____
2nd most serious problem	_____	_____	_____	_____	_____
3rd most serious problem	_____	_____	_____	_____	_____

25. If the most serious problem was eliminated, do you think recreation use on this lake would change?

No _____ Go to Question 26
Yes _____

Which activities are likely to be involved? Please circle the direction of change.

Swimming ..... More / Less by _____%
Fishing ..... More / Less by _____%
Boating ..... More / Less by _____%
Other: (Specify)
_____ More / Less by _____%

What do you think the main area of increase or decrease in use would be: (Please circle the direction of change.)

Tourists Using Area Accommodation
(includes cottagers)

No Change ..... _____
More / Less use by locals ..... _____
More / Less use by rest of Ontario ..... _____
More / Less use by other provinces ..... _____
More / Less use by other countries ..... _____

Day Users (go home at night)

No Change ..... _____
More / Less use by locals ..... _____
More / Less use by non-locals ..... _____

26. If the quality of the water was improved, do you think your resort value is likely to change?

No Change _____
Increase _____
Decrease _____

G) RESORT/MARINA REVENUES

27. Please indicate the gross revenue range which your resort or marina operated in during 1985. (Check one)

less than $50,000	_____	$250,000 - $499,999	_____
$50,000 - $99,999	_____	$500,000 - $1,000,000	_____
$100,000 - $249,999	_____	$1,000,000 plus	_____

28. What percentage of your 1985 gross revenue came from:

_____% Ontario residents
_____% other Canadian residents
_____% other country residents

29. The employees working regularly at your business can be classified into full-time (includes the manager) and part-time (i.e., work less than 30 hours per week). How many people work at your facility during the following months:

	MAY	JUNE	JULY	AUG	SEPT	OCT
Full-time employees	___	___	___	___	___	___
Part-time employees	___	___	___	___	___	___

30. Approximately what share of your gross revenues is paid as wages to employees?

Wages paid represent $_____ (or_____% of sales).

(Includes manager's wages Yes _____ No _____)

H) Do you have any comments or other information which appears to be relevant to our study and which will help us to better understand the recreational use of the lake. (i.e., Are there other important factors, such as the Canada-U.S. $ exchange rate, which significantly affects the level of recreation use of the lake?)

_____

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR CO-OPERATION . A SUMMARY OF THE PROJECT RESULTS WILL BE AVAILABLE WHEN THE STUDY IS COMPLETED.

QUESTIONNAIRE

Office Use Only
Lake _____

For information contact:
The DPA Group Inc.
903 - 347 Bay Street
Toronto, Ontario
M5H 2R7
Phone: (416) 368-1711
Attention: Brian McGowan or
Sophia Lukovich

ONTARIO MINISTRY OF THE ENVIRONMENT
CONFIDENTIAL RECREATION AND WATER QUALITY SURVEY

LOCAL OFFICIALS

This survey/interview concerns present recreation use and water quality issues on Lake _____. We are interested in your views of the role of water quality in recreation.

Please respond to the following questions to the best of your ability (estimate reasonable values if precise data are not available).

For the purposes of examining the economic impact of recreation expenditures, we need to distinguish between the local and non-local economy. (Trading area or county boundaries are sometimes appropriate and may have recorded data for comparisons.) What do you consider to be the local area around _____.

_____

_____

_____

_____

Organization: _____
Street: _____
City/Town: _____

Name of Respondent: _____
Position: _____
Phone Number: _____
Date Completed: _____

A) FACILITIES AND RECREATION ACTIVITY

1. How many resort facilities and independent marina facilities are located along this lake?

_____ resort facilities _____ independent marina facilities

2. Approximately what share of groups using lakeside accommodation facilities live:

In the local area	____%
In the rest of Ontario	____%
In other provinces	____%
In other countries	____%
Total	100%

3. For facilities in the area, what percentage of guests come from out of province?

Fixed roof accommodation	____% guests from out of province
Campgrounds	____% guests from out of province
Trailer parks	____% guests from out of province

4. The recreation users at the lake can be divided into day users, cottagers, and resort accommodation users (i.e. users of rooms, campsites, trailor sites). Based on your experience in the area, indicate the split of summer recreation users on the whole lake among the following categories:

Resort guests	____%
Cottagers	____%
Day users and others	____%
Total	100%

5. What are the three most frequent recreation activities of lake users? (Mark 1 - most frequent, 2 - second most frequent, 3 - third most frequent beside those listed below.)

	Guests Using Accommodation	Day Users
Swimming	____	____
Fishing	____	____
Boating (includes canoeing, sailing waterskiing, windsurfing)	____	____
Hiking/walking	____	____
Picnicing	____	____
Bicycling	____	____
Games (tennis, baseball, etc)	____	____
General relaxation	____	____
Other: (Specify)		
_____	____	____

6. Where public beaches and boat launching facilities exist, approximately how many people use these facilities over the summer?

_____
_____
_____
_____

B) LOCAL EXPENDITURE PATTERNS

7. For purchases of (non-labour) goods and services by resorts, what share of such purchases would be made locally?

_____% of resort purchases made locally

8. What share of total expenditures by local residents would be made in the local region as opposed to in other regions of Ontario or out of province?

_____% of consumer expenditures made locally

9. For those local consumer expenditures, what share of such goods and services are produced in the local region?

_____% of goods and services produced locally

C) WATER QUALITY AND RECREATION USE

10. What are the main substitute sites for water-based recreation in the local area?

	Substitute Lakes for	
Fishing	Boating	Swimming
_____	_____	_____
_____	_____	_____
_____	_____	_____

11. Does this lake offer any unique features (e.g., species of fish present) as compared to other lakes in the local area?

No _____ Go to Question 12

Yes _____ (specify) _____

12. Has sport fishing activity on this lake increased, decreased or remained the same over the past 20 years (or as long as you have been associated with the lake)?

(check one)

Do not know ____
Remained the same ____
Decreased ____
Increased ____ } Why? _____

13. Has non-fishing recreation activity increased, decreased or remained the same over the past 20 years (or as long as you have been associated with the lake)?

(check one)

Do not know ____
Remained the same ____
Decreased ____
Increased ____ } Why? _____

14. Which of the following do you see as a problem(s) on this lake in general? Classify as: major problem, minor problem, or no problem.

	Major Problem	Minor Problem	No Problem
Lack of desireable fish species If a problem, specify species _____	____	____	____
Low catch rates of desireable species If a problem, specify species _____	____	____	____
Small size of fish If a problem, specify species _____	____	____	____
Fitness of fish for eating If a problem, specify species _____	____	____	____
Crowding of boats in water	____	____	____
Crowding of swimmers/beach users	____	____	____
Water clarity	____	____	____
Presence of weeds/aquatic plants	____	____	____
Presence of algae scums/accumulations	____	____	____
Bacterial contamination	____	____	____
Acid rain	____	____	____
Oil, grease, scum or floating debris	____	____	____
Fitness of water for drinking	____	____	____
Foul odours from the lake	____	____	____
Chemical pollution: (Specify) _____	____	____	____
Other: (Specify) _____	____	____	____

15. What do you consider to be the three most serious problems of those noted above?

Most serious problem _____
_____

Second most serious problem _____
_____

Third most serious problem _____
_____

16. During the time which you have been associated with this lake, has there been a change in any of these problem areas?

NO _____ Go to Question 17

YES _____ Indicate below, the direction of the change and the time period over which you have noticed the change.

	Became Worse	Became Better	Remained Same	Do Not Know	Time Period (in years)
Most serious problem	_____	_____	_____	_____	_____
2nd most serious problem	_____	_____	_____	_____	_____
3rd most serious problem	_____	_____	_____	_____	_____

17. If the water quality problem of _____ was eliminated on this lake, do you think the aggregate level of the following water-based activities would increase, decrease or remain the same?

	Would Increase	Would Decrease	Remain the same	Do Not Know
Fishing days	_____	_____	_____	_____
Boating days	_____	_____	_____	_____
Swimming days	_____	_____	_____	_____
Other recreation days	_____	_____	_____	_____

18. If eliminating the water quality problem of _____ would result in an <u>increase</u> in recreation days in this lake, would the increase in use decrease recreation activity at other lakes in the local area?

	No	To Some Extent	To a Large Extent	Do Not Know
Fishing	_____	_____	_____	_____
Boating	_____	_____	_____	_____
Swimming	_____	_____	_____	_____

19. If eliminating the water quality problem of _____ would result in a <u>decrease</u> in recreation days in this lake, would the decrease in use increase recreation activity at other lakes in the local areas?

	No	To Some Extent	To a Large Extent	Do Not Know
Fishing	_____	_____	_____	_____
Boating	_____	_____	_____	_____
Swimming	_____	_____	_____	_____

20. If fishing quality has changed in this lake over the past 20 years, has the change primarily been due to changes in fishing effort or changes in water quality?

_____
_____
_____
_____

21. Do you have any comments or other information which appears to be relevant to our study and which will help us to better understand the recreational use of the lake? (i.e., Are there other important factors, such as the Canada-U.S. $ exchange rate, which significantly affects the level of recreation use of the lake?)

_____
_____
_____
_____
_____
_____
_____
_____
_____

THANK YOU FOR YOUR CO-OPERATION . A SUMMARY OF THE PROJECT RESULTS WILL BE AVAILABLE WHEN THE STUDY IS COMPLETED.

APPENDIX I

ALTERNATE DEMAND FORMULATIONS

APPENDIX I
ALTERNATE DEMAND FORMULATIONS

The availability and quality of data have a great influence on the choice of analytic approach. To estimate a complete demand curve from which one can derive economic value or welfare benefits from a change in recreation quality, one requires the following site-specific information for individual recreationists[1]:

- travel patterns -- origin/destination and purpose of trip
- transport costs
- time costs (in-transit and on-site)
- recreation related expenditures (accommodation, food, equipment, and services)
- recreation activity (days angling, swimming, boating, other)
- site characteristics (services available)
- recreation quality features (e.g., angler catch rates, water clarity, weed density)
- socio-economic profile (income, education, etc.).

From the above data set one can estimate a recreation demand curve for an individual lake or system of lakes[2] using the travel cost method or the hedonic travel cost method.

The logic of the simple travel cost method or any of its variations is that recreationists at a given site pay an implicit price for using the site services through the travel, time, equipment, and other costs associated with using that site. Since recreationists visit a site from various origins, their travel behaviour in terms of recreation days and travel costs (including time, equipment, etc.) can be used to trace a demand curve with recreation quality as an element of the estimated equation(s).

An alternate approach for estimating the benefits of changes

in water quality is to directly ask individuals about their willingness to pay for recreation products (days) differing in environmental quality -- the contingent valuation approach.[3] The answers to the hypothetical questions can be used to "value" different recreational products. There are many survey question formats, including direct (open-ended) questions, bidding games, and asking individuals whether they are willing to pay various given amounts (discrete choice logit models[4]).

Data Issues

No contingent value survey data exist for Ontario lakes. At the same time, available data from the Statistics Canada quarterly travel survey[5] and the 1982 Ontario travel survey[6] are judged inadequate to estimate the recreation benefits using an econometric approach for benefits of water quality improvements on the lakes under study.

The inadequacies of the travel survey data are as follows:

- The data are not specific to aquatic-based recreation on the six lakes under study, i.e., do not differentiate recreation use by lake and do not differentiate between aquatic-based recreation and other recreation such as camping, hiking, or hunting.

- The data only refer to people travelling a certain minimum distance (50 or 100 miles). Much of the recreation use on a lake, however, may be by local residents.

- The data do not give the number of recreation days, only the length of the trip or person-trip days. A considerable part of each trip may be spent travelling or in non-recreation pursuits. (All expenditures are attributed to recreation activity as well.)[7]

These problems are severe enough to indicate that estimating a demand equation using these data is ill-advised.

The Victor and Burrell Study

A study estimating the change in angling economic value arising from acid rain in the Haliburton/Muskoka region uses a variation of the travel cost method -- the so-called "Talhelm approach."[8] The study defines different quality recreation products based on discriminant analysis. It then calculates the economic disbenefits due to acid rain of anglers travelling to the next closest angling site in order to maintain the quality of the angling experience, i.e., the supply curve shifts upwards as the result of the acid rain.

Although the study is thorough and well-executed, it does not provide a generally applicable, operational model of the recreation benefits of lake reclamation. Along with the three data problems described above, the study has the following shortcomings:

- The definition of products in the study is arbitrary[9] and does not allow for a continuous gradient of recreation quality in the analysis, e.g., the number of different products has to be substantially less than the number of lakes.

- Viewing the impact of a recreation quality change as a shift in the demand curve and not the supply curve (as in the Talhelm approach) is preferred.[10]

- The detail of the approach, its data requirements and calculations, restricts its use as a generic approach to environmental quality problems.

Conclusions

No suitable primary data are available from which to estimate a complete aquatic-based recreation demand equation, and no "on the shelf" demand equations are useful to the present exercise.

Because of these and budget restrictions, the economic value framework used in this study is relatively straightforward. It incorporates the important determinants of recreation demand and relies on the results of other research for values of average consumer surplus per day and the elasticity or responsiveness of recreation demand to changes in recreation quality.

FOOTNOTES

1. The list is generally consistent with that proposed by Hanna.

   J.E. Hanna, "Data Availability and Requirements for Acid Rain Impact Evaluation", Proceedings of the Acid Rain Evaluation Seminar, Ed. by R.V. Huntley and R.Z. Rivers, Canadian Special Publication of Fisheries and Aquatic Sciences 90, Ottawa, 1986, pp. 95-99.

2. The virtues and applicability of single site versus multiple site (regional) demand models are investigated in: John B. Loomis, Cindy F. Sorg, and Dennis M. Donnelly, "Evaluating Regional Demand Models for Estimating Recreational Use and Economic Benefits: A Case Study", Water Resources Journal, 1986.

3. For a discussion of alternative travel cost and contingent valuation approaches, see: W.H. Desvousges and V.K. Smith, Benefit-Cost Handbook for Water Programs Volume I, Report prepared for the US Environmental Protection Agency, Research Triangle Institute, Research Triangle Park, North Carolina, April, 1983, Chapter 3.

   John F. Dwyer, John R. Kelly, and Michael D. Bowes, Improved Procedures for Valuation of the Contribution of Recreation to National Economic Development, Report prepared for the US Department of the Interior, Office of Water Research and Technology, September, 1977.

Andrew Berczi, "Estimating the Economic Consequences of Acid Rain on Sport Fishing -- An Overview", Proceedings of the Acid Rain Evaluation Seminar, Ed. by R.V. Hartley and R.Z. Rivers, Canadian Special Publication of Fisheries and Aquatic Sciences 90, Ottawa, 1986.

4. For an application of this approach, see: The DPA Group Inc., Economic Valuation of the BC Tidal Sport Fishery, Report prepared for the Department of Fisheries and Oceans, Pacific Region, March, 1985.

5. Statistics Canada, ...

6. Ontario Ministry of Tourism and Recreation, Ontario Travel Survey: Volume I, Toronto, September, 1983.

7. This problem is discussed in: A.E. Haspel and F.R. Johnson, "Multiple Trip Bias in Recreation Benefit Estimation", Land Economics, Vol. 58, no. 3:364-372.

8. Victor and Burrell, "An Economic Assessment of Acid Rain Impacts on Sport Fishing in the Haliburton/Muskoka Region", Report prepared for the Department of Fisheries and Oceans, January, 1983.

9. C. Southey, "The Use of Indirect Techniques in the Supply and Demand for Recreational Fishing", Proceedings of the Acid Rain Evaluation Seminar, Ed. by R.V. Hartley and R.Z. Rivers, Canadian Special Publication of Fisheries and Aquatic Sciences 90, Ottawa, 1986.

10. See, for example, Desvousges and Smith, op. cit. and A. Myrick Freeman, The Benefits of Environmental Improvement: Theory and Practice, Johns Hopkins Press for Resources for the Future, Inc., 1979, Chapter 8.

One problem is that if a person still fishes on a lake experiencing declining catch rates due to acid rain (i.e., his costs remain the same), the Talhelm approach suggests there is no welfare loss to these anglers.

APPENDIX J

REVIEW OF RECREATION EXPENDITURE, VALUE, AND ELASTICITY DATA

EXHIBIT J.1: EXPENDITURE LEVEL PER RECREATION DAY FROM SELECTED STUDIES

	REGION	YEAR	ACTIVITY	EXPENDITURE LEVEL	COMMENTS
1.	Bay of Quinte/ Ontario	1984	Fishing	$66.32/angler day[1]	non-res of local region
				$40.66/angler day[1]	local residents
2.	Average of 3 Provincial Parks/ Ontario	1980	Visiting park	$37.05/day visitor party[2]	All
				$11.90/day visitor party[2]	home & en route
				$14.96/day visitor party[2]	local area
				$10.19/day visitor party[2]	return trip
				$ 6.34/campernight[2]	All
				$ 2.18/campernight[2]	home & en route
				$ 2.86/campernight[2]	local area
				$ 1.30/campernight[2]	return trip
3.	Muskoka Lakes Area/Ontario	1983	Second home ownership	$62.89/party day[3]	local area
				$12.89/person day[3]	expenditures
4.	Long Point Marsh, Lake Erie/Ontario	1978	Fishing	$10.33/person visit	total expenditure
			Fishing	$ 4.88/person visit	local expenditure
			Hunting	$26.82/person visit	total expenditure
			Hunting	$12.66/person visit	local expenditure
			Nature view	$ 5.29/person visit	total expenditure
			Nature view	$ 2.46/person visit	local expenditure
5.	Province of Ontario	1980	Fishing	$12.09/angler day[4]	Ontario resident
				$26.70/angler day[4]	non-resident
6.	Province of Ontario	1982	Travel within Ontario	$23.68/person day	same day trips
				$15.32/person day	overnight trips
				$19.38/person day	all trips
7.	Victoria/ BC	1984	Salmon fishing	$17.32/angler day[5]	residents and
	Port Alberni/BC		Salmon fishing	$20.11/angler day[5]	non-residents of
	Campbell River/BC		Salmon fishing	$24.59/angler day[5]	province
	Sechelt/ BC		Salmon fishing	$28.59/angler day[5]	
	Campbell River Guided/ BC		Salmon fishing	$123.17/angler day	

[1] Figures include pro-rated cost of durable goods.
[2] Figures exclude durable items.
[3] Figures include durable items, but exclude cost of cottage and taxes.
[4] Figures exclude capital expenditures.
[5] Figures exclude capital costs and non-local costs (the Campbell River Guided expenditure level is higher since boat, gear, and a guide are included).

EXHIBIT J.2: AVERAGE CONSUMERS SURPLUS PER RECREATION DAY FROM SELECTED STUDIES

	REGION	YEAR	ACTIVITY	CONSUMER SURPLUS LEVEL	METHOD
1.	Muskoka Lakes Area/ Ontario	1981	Sportfishing	$16.66/angler day	Talheim approach
2.	Fee fishing sites/ USA	1979	trout fishing	$15.60(US)/fishing day	travel cost
			catfish fishing	$10.62(US)/fishing day	travel cost
3.	Adirondack Mtn Region/ New York	1976	Fishing	$19.90(US)/angler day	travel cost
4.	Snake River/ Idaho	1983	Fishing	$16.97(US)/fishing day	travel cost
5.	Long Point Marsh, Lake Erie/ Ontario	1978	Fishing, Hunting, nature viewing	$13.10/person visit	travel cost
6.	Victoria/ BC	1984	Salmon fishing	$21.11/angler day	contingent
	Port Alberni/ BC		Salmon fishing	$73.18/angler day	valuation
	Campbell River/ BC		Salmon fishing	$35.60/angler day	(willingness
	Sechelt/ BC		Salmon fishing	$41.34/angler day	to
	Campbell River Guided/ BC		Salmon fishing	$83.87/angler day	pay)
7.	Victoria/ BC	1984	Salmon fishing	$ 60.50/angler day	contingent
	Port Alberni/ BC		Salmon fishing	$138.14/angler day	valuation
	Campbell River/ BC		Salmon fishing	$ 79.72/angler day	(compensation
	Sechelt/ BC		Salmon fishing	$ 60.94/angler day	required)

EXHIBIT J.3: ELASTICITIES OF CONSUMERS SURPLUS WITH CHANGE IN RECREATION QUALITY

REGION	ACTIVITY	QUALITY FACTOR	IMPACT ON VALUE PER DAY[1] OF 10% CHANGE IN QUALITY
Fee fishing sites/ USA	Trout fishing	Catch rate	1.4%
	Catfish fishing	Catch rate	1.2%
Vcitoria/ BC	Salmon fishing	Catch rate[2]	1.4%
Port Alberni/ BC	Salmon fishing	Catch rate	0.5%
Campbell River/ BC	Salmon fishing	Catch rate	1.7%
Sechelt/ BC	Salmon fishing	Catch rate	1.4%

[1] Consumers surplus value.
[2] All BC elasticities refer to changes in proportions of anglers catching a salmon as opposed to changes in catch rates per se.

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APPENDIX K

ECONOMIC MULTIPLIERS FOR THE STUDY REGIONS

APPENDIX K
ECONOMIC MULTIPLIERS FOR THE STUDY REGIONS

Economic multipliers are estimated for the local regions in this study through the use of an Keynesian-type multiplier framework. In this appendix, the methodology and the data sources supporting the analyses are presented.

K.1 Regional Purchasing and Spending Patterns

Three broad local study areas exist: the Rice Lake local area, the West Lake local area, and the Muskoka/Haliburton local area (Section 3.3).

Income and employment impacts of aquatic-based recreation in the local region depend on the purchasing patterns of businesses and households, in particular the proportion of consumer purchases made locally and, in turn, the proportions of supply purchases of local businesses made locally. Discussions with resort owners and local officials aided the identification of purchasing patterns.

Each of the local areas is relatively mature so that resort owners purchase the vast majority of their supplies locally -- an estimated 90% for each of the three regions. Direct purchases by recreationists for food, supplies, etc. would have a much lower local content than that for resort purchases.

Differences exist with respect to the content of consumer goods and services in each region. The Rice Lake area (i.e., Peterborough) has a larger manufacturing base than the other two areas. The Muskoka/Haliburton area has to import a large share of food from outside the local area even in the summer. For the Rice Lake, West Lake, and Muskoka/Haliburton regions it is estimated that only 25%, 20%, and 15% of consumer goods are produced locally.

Consumers tend to purchase food and day to day items locally, but may travel further afield for clothing and major durables such as cars and televisions. For each of the three regions, an estimated 80% of total consumer purchases are made locally.

K.2 Income Multipliers

The above information from the resort owner and local official surveys, as well as secondary data, are used to estimate income multipliers for each of the three study regions. The multiplier framework is adapted from work done by H. Craig Davis.[1]

$$\begin{array}{lcl} \text{Total Income} & = & \text{Direct Income} + \text{Indirect Income} + \text{Induced Income} \\ & = & (\text{Direct} + \text{Indirect}) \text{ Income} \times \text{Keynesian Consumption Multiplier} \end{array}$$

Let E = initial tourist expenditure
a = proportion of value added to expenditure
k_1 = share of local purchases to total purchases for regional business
t = tax rate
s = savings rate
l = share of consumer purchases made locally to all purchases by locals
m = average import content of local consumer goods
c = marginal propensity to consume local goods
= (1-t-s)l

$$\text{Direct Income} = E \times a$$

$$\text{Indirect Income} = (1-a)E \times \frac{k_1}{1-k_1} \times a$$

$$\text{Keynesian Consumption Multiplier} = \frac{1}{1-c\ (1-m)}$$

$$\text{Total Income} = E\ [a + (1-a) \times \frac{k_1}{1-k_1} \times a]\ \frac{1}{1-c\ (1-m)}$$

Total Income Multiplier = Total Income/E

The parameter values applied to the above framework are illustrative. No published multipliers exist for the three study regions (Exhibit J.1). For purposes of this study, the following income multipliers are used:

Rice Lake Area	.70
West Lake Area	.65
Muskoka/Haliburton Area	.60

For example, .70 times incremental recreation expenditures represents the estimated income (value added) impact of lake reclamation activities in the Rice Lake area.

As a point of comparison, the Ontario Ministry of Tourism and Recreation has estimated income multipliers of 1.13 for Metro Toronto and 1.25 for the Province of Ontario.[2] Income multipliers for the three regions under study are considerably lower.

The Ministry of Tourism and Recreation multiplier is used to estimate provincial impacts of incremental expenditures.

K.3 Employment Multipliers

The Ontario Ministry of Tourism and Recreation employment multiplier was 5.70 person-years of employment per $100,000 of tourism expenditure in 1982*. This equivalent to a multiplier of 4.97 person-years of employment per $100,000 of 1985 tourism expenditures[3].

Local area employment multipliers were estimated under the assumption that the ratio of local area to provincial employment multipliers is equal to the ratio of local area to provincial income multipliers (e.g., Rice Lake employment multiplier of 2.8 equals 5.0 x .70/1.25). This is an approximation. In reality, one would expect some variance in the relative positions of the income and employment multipliers.

The estimated employment multipliers used in this study are:

Province of Ontario	-	5.0 jobs/$100,000 exp.
Rice Lake Area	-	2.8 jobs/$100,000 exp.
West Lake area	-	2.6 jobs/$100,000 exp.
Muskoka/Haliburton area	-	2.4 jobs/$100,000 exp.

EXHIBIT K.1: INCOME MULTIPLIERS FOR THE STUDY REGIONS

	Local Region		
	Rice Lake	West Lake	Muskoka/ Haliburton
Parameter Values			
a	.30	.30	.30
k_1	.60	.575	.55
t	.25	.25	.25
s	.10	.10	.10
l	.80	.80	.80
m	.75	.80	.85
c	.52	.52	.52
Multipliers			
Direct Income/Exp.	.30	.30	.30
Indirect Income/Exp.	.32	.28	.26
Keynesian Multiplier	1.15	1.12	1.08
Total Income Multiplier	.71	.65	.60

Sources:

a - Marshall, Macklin Monaghan Limited and A.D. Revell Associates, "Prince Edward County Tourism Master Plan", Appendix C, p. 24,

k_1 - simple average of share local purchases for resort owners (estimated at .90 from the resort owner survey), and the share of local purchases for other business (judgemental estimates of .30, .25 and .20 for Rice Lake, West Lake and Muskoka/Haliburton respectively)

t,s - judgements based on experiences in other regions of Canada and based on data in Ontario Ministry of Tourism and Recreation, The Economic Impact of Tourism in Ontario and Regions, 1982, Toronto, June 1984, Appendix F.

l - resort owner survey estimate
m - local offical survey estimate
c - calculated as (1-t-s)l

FOOTNOTES

1. H.Craig Davis, "B.C. Regional Economic Multipliers", Report Prepared for British Columbia Lands, Parks and Housing, September, 1985.

2. Ontario Ministry of Tourism and Recreation, The Economic Impact of Tourism in Ontario and Regions, 1982, June 1984.

3. Based on movements of the Canada All Items CPI between 1982 and 1985.

APPENDIX L

BASE CASE OUTPUT FROM MODEL

Base case (formally sen 9)
Feb 24/87 - Ontario Lakes Study

ONTARIO LAKES	WEST LAKE	RICE LAKE	THREE MILE LAKE	VERNON LAKE	MARY LAKE	FAIRY LAKE
WATER QUALITY MEASURES						
Original Phosphorus Concentrations (Micrograms/l)	52.0	41.30	18.00	11.00	7.00	8.00
Percent Change in Phosphorus	-25.0	-25.0	-25.0	-25.0	-25.0	-25.0
MORPHOEDAPHIC INDEX						
Original MEI	49.2	49.0	8.4	1.9	1.1	1.0
New MEI	20.91	20.83	3.57	0.81	0.47	0.43
Percent change in CPUE Perferred Species	36.62	36.62	36.62	36.62	36.62	36.62
SECCHI DISC (Metres)						
Original SD Reading (calc.)	1.83	1.18	2.30	6.56	6.73	5.82
New SD Reading	2.51	1.67	3.08	7.18	7.32	6.58
Percent change in SD	36.99	41.96	33.63	9.46	8.67	13.00
CHLOROPHYLL a CONCENTRATION (MICROGRAMS PER l)						
Original Concentration	11.2	19.1	8.3	1.0	0.9	1.5
New Concentration	7.38	12.59	5.47	0.66	0.59	0.99
Percent change in Chlorophyll a	-34.11	-34.11	-34.11	-34.11	-34.11	-34.11
ORIGINAL AVERAGE CONSUMER SURPLUS (1985 $)						
LOCAL						
Fishing	10.00	10.00	10.00	10.00	10.00	10.00
Swimming	5.00	5.00	5.00	5.00	5.00	5.00
Boating	10.00	10.00	10.00	10.00	10.00	10.00
OTHER ONT.						
Fishing	20.00	20.00	20.00	20.00	20.00	20.00
Swimming	10.00	10.00	10.00	10.00	10.00	10.00
Boating	20.00	20.00	20.00	20.00	20.00	20.00
ORIGINAL RECREATION DAYS (000'S)						
Local	30.30	69.60	9.00	28.80	20.80	18.40
Other Ont.	313.40	757.60	152.80	184.50	182.70	15.70
Out-of Prov.	43.30	394.20	1.20	16.20	16.90	4.00
ORIGINAL DISTRIBUTION OF RECREATION DAYS (PROPORTION)						
Local						
Fishing	0.10	0.50	0.15	0.05	0.03	0.03
Swimming	0.65	0.25	0.60	0.60	0.60	0.60
Boating	0.25	0.25	0.25	0.35	0.37	0.37
Other Ont.						
Fishing	0.10	0.50	0.15	0.05	0.03	0.03
Swimming	0.65	0.25	0.60	0.60	0.60	0.60
Boating	0.25	0.25	0.25	0.35	0.37	0.37
Out-of-Prov.						
Fishing	0.10	0.50	0.15	0.05	0.03	0.03
Swimming	0.65	0.25	0.60	0.60	0.60	0.60
Boating	0.25	0.25	0.25	0.35	0.37	0.37

TOTAL ORIGINAL CONSUMER SURPLUS (1985 $000's)						
LOCAL						
Fishing	30.30	348.00	13.50	14.40	6.24	5.52
Swimming	98.48	87.00	27.00	86.40	62.40	55.20
Boating	75.75	174.00	22.50	100.80	76.96	68.08
Total Local	204.53	609.00	63.00	201.60	145.60	128.80
OTHER ONT.						
Fishing	626.80	7576.00	458.40	184.50	109.62	9.42
Swimming	2037.10	1894.00	916.80	1107.00	1096.20	94.20
Boating	1567.00	3788.00	764.00	1291.50	1351.98	116.18
Total Other Ont.	4230.90	13258.00	2139.20	2583.00	2557.80	219.80
ELASTICITIES WRT CONSUMER SURPLUS						
Fishing	0.15	0.15	0.15	0.15	0.15	0.15
Swimming	0.10	0.10	0.10	0.10	0.10	0.10
Boating	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
ELASTICITIES WRT RECREATION DAYS						
Fishing	0.10	0.10	0.10	0.10	0.10	0.10
Swimming	0.05	0.05	0.05	0.05	0.05	0.05
Boating	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
NEW RECREATION DAYS (000's)						
LOCAL						
Fishing	3.14	36.07	1.40	1.49	0.65	0.57
Swimming	20.06	17.76	5.49	17.36	12.53	11.11
Boating	7.70	17.70	2.29	10.25	7.83	6.90
Total Local	30.90	71.54	9.18	29.11	21.01	18.51
OTHER ONT.						
Fishing	32.49	392.67	23.76	9.56	5.68	0.49
Swimming	207.48	193.37	93.22	111.22	110.10	9.48
Boating	79.69	192.63	38.85	65.68	68.75	5.91
Total Other Ont.	319.65	778.67	155.83	186.46	184.53	15.88
OUT-OF-PROV.						
Fishing	4.49	204.32	0.19	0.84	0.53	0.12
Swimming	28.67	100.62	0.73	9.77	10.18	2.42
Boating	11.01	100.23	0.31	5.77	6.36	1.51
Total Out-Of-Prov.	44.16	405.16	1.22	16.37	17.07	4.05
NEW AVERAGE CONSUMER SURPLUS (1985 $)						
LOCAL						
Fishing	10.55	10.55	10.55	10.55	10.55	10.55
Swimming	5.18	5.21	5.17	5.05	5.04	5.03
Boating	10.34	10.34	10.34	10.34	10.34	10.34
OTHER ONT.						
Fishing	21.10	21.10	21.10	21.10	21.10	21.10
Swimming	10.37	10.42	10.34	10.09	10.09	10.13
Boating	20.68	20.68	20.68	20.68	20.68	20.68
TOTAL NEW CONSUMER SURPLUS (1985 $000's)						
LOCAL						
Fishing	33.13	380.56	14.76	15.75	6.82	6.04
Swimming	104.01	92.55	28.38	87.63	63.21	56.28

Boating	79.67	183.00	23.66	106.02	80.94	71.60
Total Local	216.81	656.11	66.80	209.39	150.98	133.92
OTHER ONT.						
Fishing	685.44	8284.82	501.29	201.76	119.88	10.3[illegible]
Swimming	2151.51	2014.81	963.57	1122.75	1110.49	96.0[illegible]
Boating	1648.08	3984.00	803.53	1358.33	1421.93	122.1[illegible]
Total Other Ont.	4485.03	14283.63	2268.39	2682.84	2652.31	228.5[illegible]
CHANGE IN CONSUMER SURPLUS (1985 $000's)						
Local	12.29	47.11	3.80	7.79	5.38	5.1[illegible]
Ont. Residents (local & other Ont.)	266.42	1072.74	132.99	107.63	99.88	13.3
IMPACT ANALYSIS						
DAILY EXPENDITURES (1985 $)						
LOCALS						
Fishing	20.00	20.00	20.00	20.00	20.00	20.0[illegible]
Swimming	5.00	5.00	5.00	5.00	5.00	5.[illegible]
Boating	15.00	15.00	15.00	15.00	15.00	15.[illegible]
OTHER ONT.						
Day-User						
Fishing	35.0	35.0	35.0	35.0	35.0	35.[illegible]
Swimming	15.0	15.0	15.0	15.0	15.0	15.[illegible]
Boating	25.0	25.0	25.0	25.0	25.0	25.[illegible]
Overnighter						
Fishing	60.0	60.0	60.0	60.0	60.0	60.[illegible]
Swimming	30.0	30.0	30.0	30.0	30.0	30.[illegible]
Boating	50.0	50.0	50.0	50.0	50.0	50.[illegible]
Cottager						
Fishing	25.0	25.0	25.0	25.0	25.0	25.[illegible]
Swimming	10.0	10.0	10.0	10.0	10.0	10.[illegible]
Boating	20.0	20.0	20.0	20.0	20.0	20.[illegible]
OUT-OF-PROV.						
Fishing	60.0	60.0	60.0	60.0	60.0	60.[illegible]
Swimming	40.0	40.0	40.0	40.0	40.0	40.[illegible]
Boating	50.0	50.0	50.0	50.0	50.0	50.[illegible]
CHANGE IN RECREATION DAYS (000's)						
LOCAL						
Fishing	0.11	1.27	0.05	0.05	0.02	0.[illegible]
Swimming	0.36	0.36	0.09	0.08	0.05	0.[illegible]
Boating	0.13	0.30	0.04	0.17	0.13	0.
TOTAL LOCAL	0.60	1.94	0.18	0.31	0.21	0.[illegible]
OTHER ONT.						
Fishing	1.15	13.87	0.84	0.34	0.20	0.[illegible]
Swimming	3.77	3.97	1.54	0.52	0.48	0.[illegible]
Boating	1.34	3.23	0.65	1.10	1.15	0.[illegible]
TOTAL OTHER ONT.	6.25	21.07	3.03	1.96	1.83	0.[illegible]
OUT-OF-PROVINCE						
Fishing	0.16	7.22	0.01	0.03	0.02	.[illegible]
Swimming	0.52	2.07	0.01	0.05	0.04	0.[illegible]

Boating	0.18	1.68	0.01	0.10	0.11	0.03
TOTAL OUT-OF-PROVINCE	0.86	10.96	0.02	0.17	0.17	0.05
DISTRIBUTION OF OTHER ONT. (Proportion)						
Day-User	0.002	0.005	0.000	0.023	0.016	0.032
Overnighter	0.859	0.537	0.250	0.618	0.739	0.586
Cottager	0.139	0.458	0.750	0.359	0.245	0.382
LOCAL IMPACTS						
LOCAL SHARE OF EXPENDITURES (proportion)						
Local						
Fishing	1.0	1.0	1.0	1.0	1.0	1.0
Swimming	1.0	1.0	1.0	1.0	1.0	1.0
Boating	1.0	1.0	1.0	1.0	1.0	1.0
Other Ont.						
DAY-USER						
Fishing	0.5	0.5	0.5	0.5	0.5	0.5
Swimming	0.5	0.5	0.5	0.5	0.5	0.5
Boating	0.5	0.5	0.5	0.5	0.5	0.5
OVERNIGHTER						
Fishing	0.8	0.8	0.8	0.8	0.8	0.8
Swimming	0.8	0.8	0.8	0.8	0.8	0.8
Boating	0.8	0.8	0.8	0.8	0.8	0.8
COTTAGER						
Fishing	0.7	0.7	0.7	0.7	0.7	0.7
Swimming	0.7	0.7	0.7	0.7	0.7	0.7
Boating	0.7	0.7	0.7	0.7	0.7	0.7
Out-of-Prov.						
Fishing	0.8	0.8	0.8	0.8	0.8	0.8
Swimming	0.8	0.8	0.8	0.8	0.8	0.8
Boating	0.8	0.8	0.8	0.8	0.8	0.8
CHANGE IN EXPENDITURE (1985 $000)						
LOCAL						
Fishing	2.22	25.49	0.99	1.05	0.46	0.42
Swimming	1.82	1.82	0.45	0.41	0.27	0.38
Boating	1.94	4.45	0.58	2.58	1.97	1.74
TOTAL LOCAL	5.98	31.76	2.02	4.04	2.70	2.53
OTHER ONT.						
Day-User						
Fishing	0.04	1.21	0.00	0.14	0.06	0.01
Swimming	0.06	0.15	0.00	0.09	0.06	0.01
Boating	0.03	0.20	0.00	0.32	0.23	0.04
TOTAL DAY-USER	0.13	1.56	0.00	0.54	0.34	0.06
Overnighter						
Fishing	47.32	357.56	10.07	10.02	7.12	0.89
Swimming	77.66	51.18	9.25	7.76	8.43	0.88
Boating	45.91	69.38	6.51	27.22	34.08	2.32
TOTAL OVERNIGHTER	170.90	478.12	25.84	45.01	49.62	3.97

Cottager						
Fishing	2.79	111.18	11.02	2.12	0.86	0.12
Swimming	3.67	12.73	8.09	1.32	0.81	0.16
Boating	2.60	20.71	6.84	5.53	3.95	0.52
TOTAL COTTAGER	9.06	144.62	25.95	8.97	5.63	0.81
TOTAL OTHER ONT.	180.08	624.31	51.79	54.52	55.60	4.54
OUT-OF-PROV.						
Fishing	7.61	346.45	0.32	1.42	0.89	0.21
Swimming	16.66	66.13	0.39	1.47	1.41	0.51
Boating	7.38	67.23	0.20	3.87	4.27	1.00
TOTAL OUT-OF-PROV.	31.65	479.81	0.91	6.76	6.56	1.72
LOCAL INCREMENTAL EXPD	211.73	1104.12	52.70	61.28	62.16	6.25
EMPLOYMENT IMPACTS (p-y)						
Local Jobs (d,i,i) per $000s expenditure	0.0260	0.0280	0.0240	0.0240	0.0240	0.0247
Total Employment (d,i,i)	5.51	30.92	1.26	1.47	1.49	0.15
INCOME IMPACTS (1985 $000's)						
Local income multiplier (d,i,i)	0.65	0.70	0.60	0.60	0.60	0.63
Local Income (d,i,i)	137.63	772.88	31.62	36.77	37.30	3.78
PROVINCAL IMPACTS						
CHANGE IN EXPENDITURES (1985 $000's)						
LOCAL						
Fishing	2.22	25.49	0.99	1.05	0.46	0.43
Swimming	1.82	1.82	0.45	0.41	0.27	0.33
Boating	1.94	4.45	0.58	2.58	1.97	1.74
TOTAL LOCAL	5.98	31.76	2.02	4.04	2.70	2.50
OTHER ONT.						
Day-User						
Fishing	0.08	2.43	0.00	0.27	0.11	0.02
Swimming	0.11	0.30	0.00	0.18	0.11	0.02
Boating	0.07	0.40	0.00	0.63	0.46	0.03
TOTAL DAY-USER	0.26	3.13	0.00	1.09	0.69	0.07
Overnighter						
Fishing	59.15	446.95	12.59	12.53	8.90	0.61
Swimming	97.08	63.98	11.56	9.70	10.53	1.03
Boating	57.39	86.72	8.14	34.03	42.60	2.93
TOTAL OVERNIGHTER	213.62	597.65	32.30	56.26	62.03	4.59
Cottager						
Fishing	3.99	158.83	15.74	3.03	1.23	0.15
Swimming	5.24	18.19	11.56	1.88	1.16	0.23
Boating	3.71	29.59	9.77	7.91	5.65	0.79
TOTAL COTTAGER	12.94	206.61	37.07	12.82	8.04	1.16
TOTAL OTHER ONT.	226.82	807.39	69.37	70.16	70.76	5.87
OUT-OF-PROV.						
Fishing	9.51	433.07	0.40	1.78	1.11	0.26
Swimming	20.82	82.66	0.48	1.84	1.76	0.62

Boating	9.23	84.03	0.26	4.83	5.33	1.26
TOTAL OUT-OF-PROV.	39.56	599.76	1.14	8.45	8.20	2.15
PROVINCIAL INCREMENTAL EXPD.	39.56	599.76	1.14	8.45	8.20	2.15
EMPLOYMENT IMPACTS (p-y)						
Provincial Jobs (d,i,i) per $000's expenditure	0.05	0.05	0.05	0.05	0.05	0.05
Provincial employment (d,i,i)	1.98	29.99	0.06	0.42	0.41	0.11
INCOME IMPACTS (1985 $000's)						
Provincial Income Multipliers (d,i,i)	1.25	1.25	1.25	1.25	1.25	1.25
Provincial Income (d,i,i)	49.45	749.70	1.42	10.57	10.25	2.69